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Issue Article

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HORIZONTAL WELL DRILLING TECHNOLOGY

Abstract*: The article discusses the experience of drilling in Turkmenistan of a directional production and evaluation well in order to restore oil production from an inactive field in the coastal zones of the coastal waters of the Caspian Sea.*

This work can be used and useful for the development of fields in difficult-to-develop shallow waters and to reduce costs during their drilling, as well as to increase the volume of oil produced in order to develop the field in an accelerated manner, without increasing the oil recovery coefficient.

Key words*: azimuth, conservation, displacement, vertical, along the trunk, intensity, combined schedule, drilling mode, downhole, wellhead.*

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Introduction

In foreign practice, with the introduction of horizontal drilling, a decrease in the cost of oil production and an increase in the hydrocarbon recovery rate have been achieved. Appropriate use of horizontal drilling in a specific field, area, horizon, reservoir, etc. determined based on economic analysis.

At present, the introduction of an improved method of field development with horizontal wells is being observed abroad in oil and gas production. The method became possible as a result of solving the main problems of horizontal wells placement in connection with the latest achievements in this direction of scientific and technological progress.

The horizontal wellbore in the productive horizon allows for a smoother withdrawal of oil from the reservoir and reduces the tendency for the formation of black depressions inherent in the vertical wellbore, along which the underlying water or gas from the lawn 4 part above the oil zone of the formation is intensively moving towards the well. With such phenomena, the life of the well is sharply reduced, the unselected part of the reserves is required, the compaction of the field development grid. Slowing down of these processes in horizontal wells makes it possible to develop oil areas with a significantly smaller thickness or with vertical wellbores. In reservoirs, where the vertical permeability is significantly greater than the horizontal, the induction through the formation, the borehole multiplies the oil flow into the well. In fractured and heterogeneous reservoirs passing through the formation, the wellbore encounters a greater number of depressions with increased permeability and porosity. Thanks to horizontal wells drilled from previously drilled wells, it is possible to extract oil remaining in certain sections of the reservoir after long-term operation [1].

Drilling of wells with horizontal boreholes in new fields abroad is carried out using such tools as: a bit, downhole motor, devices for controlling the trajectory of the wellbore without the need to lift the drill string in order to replace the BHA (bottom hole assembly), a system for measuring bottomhole parameters in the process of chiseling, a system of devices with an upper rotation. The latter is necessary as a means of increasing the likelihood of reaching the design mark (reducing the likelihood of well loss due to technical reasons). Exceptional attention is paid to technical drilling, including the quality of the drill cut, the drilling regime, and the separation of layers. The success of wells placement is largely determined by its preparation for implementation (planning work before starting it) and operational planning to optimize decision-making while drilling. For this purpose, a computer with special software packages is widely used, including a serious base and a knowledge base.

One of the main tasks of preliminary planning and work is to choose the optimal trajectory of the future wellbore. For this purpose, advanced methods of three-dimensional seismic prospecting are intensively used. Foreign experts point out that the future of oil and gas production applications is a combination of horizontal drilling and 3D seismic exploration. In the presence of data on productive formations, it is necessary to issue the most economical technology, which is determined by the target task that the production company sets for horizontal drilling, perhaps the formation and drilling conditions during the work. The technology is largely determined by the radius of curvature in the zone of transition from the vertical direction of the barrel to the horizontal one. Currently, there are three main types of technologies: Large radius, medium radius and small radius.

Directional wells are constructed in a wide variety of conditions: on land and in the open sea, from separate offshore structures and from flyovers, in impenetrable swamps, forests and deserts, on flat and mountainous terrain, at various times of the year, in the south and north, in the west and in the east of our country. Directional wells are drilled mainly in the development of oil and gas fields and only in small quantities in the exploration of productive deposits or delineation of fields [2].

The location of productive oil and gas reservoirs, the number of industrial horizons, the nature of the rock permeable and their occurrence in the geological section of the field usually do not cause difficulties in the construction of inclined wells. Directional wells are successfully constructed with the same standard drilling rigs (DR-50, DR-75, etc.) as vertical wells. Some modernization of drilling equipment (derrick, crown block, rotor), caused by the close location of directional wellheads in the cluster, did not significantly change the design of the facing drilling rigs.

Directional wells can be drilled by any of the currently used industrial methods: rotary, turbine and electric drill on pipes. But directional drilling crews need to be more dusty than vertical drilling crews due to the difficulty of directional drilling.

The technological process of directional drilling includes a number of additional specific operations compared to vertical drilling: recruitment, reduction and stabilization of the borehole inclination angle, etc. conditions associated with an increase in the calendar time of drilling directional wells. In contrast to vertical wells, the success of drilling - directed wells is judged not only by the commercial speed and cost per meter of penetration, but also by the quality of execution, the projected profile. Any negligence in performing certain specific operations affects the quality of directional well drilling. Excessive deviation of the directional wellbore from the design profile may cause the need for complete or partial abandonment of the already drilled part of the well, so as not to disrupt the geological grid of drilling the field. In the future, when such a directional well comes into operation and oil production is carried out in a mechanized way, there will be difficulties in the overhaul of the well. In the case of deep pumping operation, intensive abrasion of the rods is added to the indicated disadvantages.

Lack of the necessary experience of workers involved in drilling and operating directional wells often predetermines a decrease in the economic performance of such wells. Along with this, not all theoretical issues related to obtaining high quality directional well drilling have been sufficiently developed. Therefore, even such a promising drilling method as parallel double-barreled drilling does not always compensate for all the time costs associated with the complication of the technological process of drilling directional wells.

Compliance with sustainable development systems is a requirement equally for both vertical and directional drilling. The bottomholes of these wells should penetrate the pay zone at the points defined by the geological grid of development. Some deviations of the actual bottomhole from the design one provided by the geological grid of development are allowed only under the following conditions: formation; b) at borehole inclination angles up to 5°, instrumentation cannot measure the position of the directional wellbore with sufficient accuracy; c) there are no technical means to ensure the sinking of a strictly vertical shaft.

Nevertheless, sometimes vertical and deviated wellbores do not correspond to the design points provided by the geological grid of development, even taking into account the existing tolerances. In the process of drilling directional wells, the position of the wellbore in space is systematically monitored. Therefore, naturally, any deviation of the directional bore from the design profile should be noticed and corrected in a timely manner.

The survey of works shows the high prospects of horizontal drilling in terms of increasing production and solving problems of well completion. As practical experience shows, horizontal drilling is becoming an important area of technological progress in terms of increasing production and solving various problems of well completion.

Before drilling a horizontal well (the customer) must provide the necessary information, including data that is usually required for planning a directional wellbore, as well as specific information related to the horizontal length of the wellbore, expected mechanical speeds, rock boreholes and plans, well completion. Based on this information, management can recommend the borehole profile (transition zone radius) and drilling system that best suits the objective requirements of the customer.

The long radius drilling method, which is the forerunner of modern horizontal drilling techniques, is preferred for production drilling.

Although a large radius is often adopted for exploration and estimation purposes of the reservoir, horizontal wells with a large radius are most useful when a large horizontal position is required, for example, when drilling fields from fixed foundations, drilling from remote sites, etc.

Depending on the length of the transition zone (section of the angle set) with a large radius of curvature, several sizes of the bore and casing may be required before the well is released to the horizontal [3].

Wells with a medium radius are used for various types of use when drilling new wells or extended previously fought ones. A profile with a medium radius makes it easier to solve the problem of underbalanced flooding of wells and allows oil and gas to be produced from rocks with natural tremor or with small thickness. With an average radius of curvature in various regions of the world, the rate of angle gain from 8^o to 20^o per 30 m has been obtained. At present, wells are drilled with sufficient languor with wellbore sizes with wellbore sizes up to 320 m. The radius at the transitional section reaches 84-210 m.

In addition to the fact that in the transition section there are fewer different rocks with an average radius, the length of the wellbore is reduced, where special control is required during drilling, a shorter length of the wellbore under the bend is given (i.e. less opportunities for). With an average radius of curvature, the friction force can decrease, a greater and more uniform rate of curvature gain is achieved than with a large radius. The sum of these practical advantages and the proven drilling systems have made medium radius the most popular horizontal drilling method [4, 5].

Wells with a small radius are ideal for small areas, for development of productive formations for workover (hardening to another horizon). With a radius of curvature in the transition section of approx. 12 m, a short curved section of the wellbore is obtained, i.e. that part of it where the most probable endings are of various kinds. Medium wells with a small radius allow very accurate determination of the structure (since a shorter borehole length is required to reach the horizontal), the vertical section is closer to the productive zone of the wellbore, which is important for saturated annuity.

The small radius profile makes it easier to work in the early drilled well. With a small radius, most of the curved section and the horizontal part of the well remain in one zone of the formation, thereby reducing the likelihood of complications during drilling and easier to prevent the formation of gas breakthrough along the depression cone.

The above solution can be taken as a basis when choosing the appropriate profile and its drilling system in order to achieve the set goal of drilling.

It should be noted that there is no single optimal method for drilling horizontal wells for all conditions.

Mastering the technology of drilling (inclined)-horizontal wells that do not have a geographic connection between the wellhead and the bottomhole. For such wells, it is possible to displace the bottomhole relative to the vertical in any required azimuth, and their mouths can be grouped and located on the ground according to economic and technical feasibility. Economic feasibility depends on the time and money spent on the entire drilling process. However, it is not always possible to deviate the bottom from the vertical by a certain distance. The deviation depends on the vertical depth to the reservoir, on the geological section, the equipment used, on the well profile, operational capabilities and a number of other conditions [6, 7, 8].

Naturally, both the drilling speed and the quality indicators of the completed well depend to a large extent on the results of drilling the directional section. The calculated elongation-increase in the definition of an inclined wellbore can only be obtained if the design profile is accurately filled with a directional well.

Everything stated on the drilling of directional wells shows that the qualitative and quantitative indicators can be significantly facilitated and improved if somehow it has the main provisions in mind [9].

Directional wells must be drilled in accordance with the developed project. When changing the layout of the bottom of the drilling tool (if those that set the angle will differ from the projected), adjustments should be made to the project, taking into account the actual data. The bottom of the drilling tool with tools should be lowered very carefully so that when drilling a directional borehole, the azimuth error is minimal. The change in the direction (azimuth) of the borehole must be pre-calculated using the device to determine the angle of the whipstock [10, 11]. The achieved angle of inclination of the trunk should not increase if it fluctuates within 5-10°, since at large angles of inclination it is much more difficult to change the direction of the trunk. The rate of incline angle should be no more than that provided for in the project. Such execution of works allows to change the direction of the wellbore with the least number of chisels, and will reduce the time of additional works. The stability of the direction (azimuth) of the trunk is achieved at tilt angles of 10-12°.

Directional wells should be designed on the basis of modern advances in technology and technology for directional drilling. Highly qualified professionals must perform this work. For each directional well, it is necessary to draw up an individual project reflecting the configuration of the profile, its calculations (which take into account the used tool and deviation methods), the well by increasing its total length compared to the vertical one. The design should reflect the intervals of work with deflectors, the layout of the bottom of the drilling tool, the rate of incline angle increase with this layout, the design deviation for the entire well and at each section of the well and the slope at the junctions of the profile sections [12].

Directional drilling should be entrusted to drilling crews with sufficient practice in drilling such wells. In the absence of sufficient practice on the part of the drilling crew, it is necessary for the driller, driller assistants, and drillers to undergo special training and pass an examination to obtain the right to drill directional wells. Drilling engineers should be sufficiently familiar with all the latest advances in technology and directional drilling technology.

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