NEW TECHNOLOGY OF DIRECTIONAL DRILLING IN OIL EXTRACTING

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Abstract
In the whole history of oil and gas industry there has been an evolution aimed at increasing the efficiency and growth of the oil recovery factor of the deposit.

Key words: oil extracting, drilling new technology, controlled adapter, robotized complex

INTRODUCTION
At the initial stage of the field development, oil was extracted from vertical wells (one-dimension) (Fig. 1) [1], their number and location were not taken into consideration, only the product availability was important. With the industry monopolization, the efficiency of investments was getting important. As a result, there was the transfer to system development of fields with vertical wells. The stage of field development with vertical drilling can be characterized as the stage of spot completion of productive deposits with one-dimension wells (Fig. 1).

Together with the simplicity and a number of technological advantages, vertical wells did not allow developing the fields under artificial and natural obstacles. To solve this problem, the technology of drilling inclined wells was developed. The drilling technology and well exploitation reached a new level. However, the deposit completion was still a spot one, though due to the initial vertical drilling, the wells became two-dimension [2] (Fig. 2).

DEVELOPMENT OF BUILDING TECHNOLOGY
Further development of building technology of inclined wells, allowed developing the drilling of horizontal wells, thus becoming a new stage in developing the efficiency of oil and gas field exploitation (Fig. 3).
significantly increasing the field coverage, surface filtration and oil recovery factor (ORF), decreasing the environmental impact, providing the significant growth of the efficiency of capital investments. The necessity of coupling with the initial vertical region results in the need to design 3D well.

Together with the changes in field development techniques there was an evolution of technical means for their implementation. Vertical wells were drilled either rotary with the drive from the rotor or cable-tool.

However in the middle of XX century, mainly in the USSR, the drilling of wells with turbo drills – multi-stage hydraulic turbines providing the rotary motion of rock-destruction tool only with hydraulic energy of drilling liquid without rotating the whole column was developed [3]. Together with increasing the drilling speed, the technology also allowed solving the issue of drilling inclined wells. In the middle of XX century the largest oil fields in Western Siberia were discovered, where the major problem was to provide the proper coverage in swampy areas.

Initially the inclined wells were drilled with turbo drills with adapter subs with the misalignment of threaded connections. As a rule, relatively large Fig. 3 – Three-dimension well turbo drills (over 10 meters) and arrangement rigidity did not allow using adapter subs with large misalignment. As a result, only the inclined wells with great curvature radius (over 350 meters) had to be drilled. However, when shifting to spindle turbo drives, the technical means for inclined drilling also change. Despite the fact that there was no significant change in the column rigidity, there appeared the possibility to bring the oblique adapter sub to the drilling bit and install it between the spindle and working part of turbo drill [4], thus 1.5 – 1.8 times decreasing the curvature radius with consequent increase in maximum inclination angles and displacements. Such change in the technology allowed sufficiently increasing the field coverage from one multiple-well platform. Turbo drills have higher rigidity due to their sizes, as well as sufficient weight, when reaching the inclination angles over 45-50° there arise problems with bringing the load to bottom hole. High frequency of motor shaft rotation does not allow applying adapter subs with great misalignment. The constant misalignment does not give the possibility to promptly control the trajectory, etc. [5].

In 1970-s screw bottom-hole motors with significantly smaller sizes were developed, which allowed providing the torques several times exceeding the torques of turbo drills. Together with bottom-hole systems of parameter control, screw bottom-hole motors made it possible to drill wells with curvature radii up to 20 meters with conditionally unrestricted inclination angles. The less motor revolutions allowed installing a special device between the operating steam and spindle that changes the inclination and, consequently, the well curvature radius. At the same time, there were some shortcomings left when applying these steering tools: change in the curvature radius is possible only when lifting the drilling tool and changing the misalignment, the curvature parameters are got with fixed drilling tools, thus decreasing the quality of well walls, the speed of drilled formation lifting, the load bringing to the bottom-hole.

In the late 1980-s a new tendency in the development of inclined and horizontal drilling appeared – controlled rotor drilling [6]. When applying this technology a number of record-breaking wells with well head displacement over 10,000 meters have been drilled. The advantages of this method: improved quality of well bore, improved returns due to the flow artificial turbulence, better load bringing to the bottom-hole.

The devices providing the column deviation can be divided into 2 groups. The first comprises all assemblies containing special fracture elements providing the curvature of the column longitudinal axis. The second – different types of column deflectors on the predetermined inclination angle (Fig. 2). In this case, the relative position of the column axis and well axis change.

The analysis of column modern structures and technologies tested in practice revealed that there is considerably better access to main deposits of hydrocarbon raw materials concentrated in hard-to-reach areas – shelves, swampy regions, tundra, permafrost areas. Besides, it is possible to produce difficult to recover stores – residual stores of old fields and deposits with low collector properties, and high-viscous oil and tar. In all the foregoing situations it is necessary to accurately drill the well
with complex trajectory, as well as to many times change the inclination angle to drill through the complicated areas, which currently requires multiple hoisting of the column. Obviously we need to drill such wells with robotized systems excluding extra technological operations.

At the same time, together with controlled rotor drilling there is a tendency of producing various devices used to change the direction of the column motion [8].

**CURRENT TECHNOLOGY OF DIRECTIONAL DRILLING**

Rough drilling conditions, impact loads, alternate conducting and dielectric layers, certain properties of drill fluids give the possibility to apply complex robotized bottom-hole systems in a very limited way. The impossibility to carefully forecast the muck properties in the drilling process, and, moreover, to produce an autonomous analytical bottom-hole complex, predetermine the necessity to use a robotized complex controlled from the surface.

Technological parameters and drilling conditions allow using hydraulic, ultra low frequency electromagnetic or cable communication channel [8]. The shortcomings of the hydraulic communication channel are: low speed of data transfer, dependence on the uniformity of drilling liquid stream, but when drilling productive deposits in a sparing mode, the possibility of sending signals is unrealistic. The electromagnetic channel depends on electrical properties of the muck and drilling liquid, which require the use of ultra-low frequencies significantly decreasing the speed of data transfer. Cable channel requires a lot of connections resulting in bridging and loss of data.

The possible solution can be the use of traditional drilling rigs produced as robotized systems with double hydraulic and electromagnetic communication channel, duplex in both channels. The use of rigs with “continuous pipes” assembled, gives the possibility to effectively apply a cable communication channel. The cable communication channel will also be effective and in demand when drilling with bottom-hole electrical motors (electrical drills) that have a number of technological advantages when compared with other drilling techniques.

The task to control the trajectory during drilling means to control the change in rotation axis of the drilling tool against the column by value, as well as by the direction against the apsidal plane. The robotized column with bottom-hole motor is controlled from the surface without any difficulty, but, as mentioned before, there are several limitations. The possibility to combine the rotation of the column and control of the drilling direction is available only with the fixed body element of the column that provides the torque transfer in the required direction. As the developed and trialed models demonstrated, the rotation axis can be effectively changed in two ways: producing the misalignment in the foregoing fixed body element similarly to the misalignment in bottom-hole motors; or decentralizing the fixed column body.

**CONCLUSION**

The analysis and approbation of the drilling columns of various models and design demonstrate that the use of a number of decentralizers as deflectors from the given movement direction results in the new technique of controlled drilling, without column hoists [7]. When the trial model, and, further, the manufactured column possess the required technical and durability characteristics, their application in practice will allow significantly increasing the drilling speed of directed and multihole wells, decreasing the process costs.

The Department of Mechatronic Systems of Izhevsk State Technical University and NPO “Gorizont” are working on entirely new scheme of the drilling column with two-contour hydraulic deflector of controlled drilling providing the change in the drilling angle from 0° up to 3° with the error 0.08° – 0.15° depending on the performance level.

**REFERENCES**


