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Research on the Application of Near-bit Measurement Technology at Home and Abroad

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Abstract: Foreign near-bit measurement technology was first developed in 1920 and has become increasingly mature. It started relatively late in China, and is still in the test stage. This paper introduces the development course of near-bit measurement technology at home and abroad, and introduces the targeted market using the best five technologies: near-bit DQNBMS-1 type of MWD system, Pathefinder near-bit geological drilling technology, near-bit CGDS LWD system, nearly bit CGDS LWD system, MRC near-bit geological system. The downhole data transmission mode of the near-bit measurement system can be divided into three types: acoustic wave, mud pulse and electromagnetic tracking measurement system. , according to the technical characteristics of near-bit analysis in Fuling area and field application situation of Shengli oilfield, real-time acquisition underground strata information, timely and accurately reflect the true physical underground, combined with logging data to complete real-time formation evaluation, the stratigraphic classification more reasonable, the reservoir porosity and fluid types of discrimination is more scientific, and improve the reservoir drilling rate.

Keywords: Near-bit measurement technology; Geological drilling technology; Fulling; Drilling rate; Mud pulse.

1. PREFACE

With the development of drilling technology, various branch Wells, long horizontal Wells arises at the historic moment, to clear the strata, judge the position and downhole drill adopts the proximal gamma MWD is the best way. At present, there are two mature technologies: near-bit follow-up drilling detection technology and rotary geological guidance technology. The latter has good effect, but it has not achieved autonomy in China. The price is in the hundreds of thousands of tons per day, which is not cost-effective compared with most development Wells. The near bit has the advantages of rotating geological guidance technology, low cost and high cost performance. It is suitable for most development Wells. Near-bit drilling detection technology is the premise and guarantee, reduce the risk of underground near the on-site technical personnel can timely and accurately grasp the bit geology, according to the change of

formation can be timely adjustment of borehole trajectory, make sure you are able to accurately through the reservoir in the best position, realize geological, improve reservoir drilling rate.

2. DEVELOPMENT AT HOME AND ABROAD

2.1 Foreign development history

(1) The first patent for measurement with drilling was born in 1929.
(2) The resistivity log transmitted by the cable in 1930 was used in the actual logging operation.
(3) The first and second-generation mud pulse telemetry system was introduced from 1969 to 1970.
(4) In 1984, electromagnetic log was officially launched on the historical stage, and the resistivity log of electromagnetic wave with drilling was invented.
(5) In 1996, Russia and Japan successively developed and successfully realized the downhole operation of the following drilling system.
(6) In 2000, a company supported by the U.S. department of energy successfully developed an intelligent drill pipe system that USES electromagnetic induction to transmit data.
(7) In 2002, schlumberger used Slim Pulse's recycled MWD system to solve the high temperature and high-pressure problems faced by long horizontal Wells, achieving the world record for horizontal drilling of 184m.
(8) In 2009, Baker-Hughes INTEQ's Navi GatorTM geological navigation system consisted of a combination of drill sensor and upper drill tool to provide basic parameters such as drill hole inclination, resistivity and gamma ray.

2.2 Domestic development

(1) In 1997, professors at the southwest petroleum institute developed and built a torque tracking telemetry system. It can display the torque of the kelly and the weight and weight of the drill tool and the drilling pressure. Subsequently, the university of petroleum (East China) invented a more practical measuring short section of the drill string, which can be measured with up to nine parameters.
(2) Since 1997, Shengli petroleum research institute has been developing the wireless tracking measurement technology. After years of unremitting efforts of engineers, a mechanical wireless tracking device was developed in 2010. Instrument by underground collection launch equipment and inoue receive processing system composed of downhole instrument measuring wall slope signal pulse transfer to receivers on the ground, according to the received signal pulses to calculate the Angle.
(3) In 2007, "CGDS-1" geological guidance drilling system for near-bit was born, which is the first set of geological guidance drilling system with independent intellectual property rights in China.
(4) In 2010, Beijing petroleum machinery factory to produce wireless while drilling system after oil field in the practical application of northeast area, the timely transmission, stability, and high rate, indeed show that the technology has been mature in domestic.

(5) In 2011, Shengli directional well designed a geological guidance instrument to transmit data by electromagnetic waves.
(6) Until now, only Beijing drilling institute and Daqing drilling institute have near - drill geological guidance system. Development of geological system has formed Y CGDS-1,172 and 203 Y two series, the system includes: CGDWD wireless inclinometer with drilling, motor and CFDS CAIMS measured ground information processing and decision-making system. The parameters of near-bit well inclination, azimuth gamma, azimuth resistivity and near-bit resistivity are configured, and the measuring point is 2.5m ~ 3.3m from the bottom of the well.

3. NEAR-BIT MEASUREMENT TECHNOLOGY

3.1 DQNBMS-1 near-bit measurement system

3.1.1 The structure

Ground processing system is responsible for the acquisition, decoding, storage and data processing of positive pulse signals. In addition, the system software also has the functions of self-diagnosis, modifying downhole tool parameter transmission sequence, data transmission rate and downloading downhole tool to record data. The downhole tool system is composed of LWD system, receiving system and measuring and transmitting motor (including near measuring main assembly).

3.1.2 Features

The DQNBMS-1 near-bit measurement system with drilling is reasonable in design and reliable in operation. It has the characteristics of multi-parameter measurement, close measurement point, high measurement precision and accurate measurement data.

3.2 Pathfinder near-bit geolocation drilling technology

3.2.1 The structure

Into the shaft assembly is: bit + PZIG nipple (measurement) + single curved screw+ float valve + PZIG nipple (receive nipple) + Change buckle connector+ conventional MWD/LWD component + Non-magnetic bearing drill pipe + Increase drill pipe+ drill pipe.

3.2.2 Features

(1) When the conventional LWD-guided measurement dead zone is shortened from 13 to 17m to less than 1m, the borehole trajectory can be adjusted in time. When the system measuring point is <1.0m, the boundary of the layer can be found in advance and adjusted in time to avoid the layer.
(2) Near-bit measurement device dynamic data error <5%. The parameters are accurate and reliable, and the curve coincidence rate is high. The formation can be accurately judged, and the quality and small layer can be determined quantitatively and qualitatively.
(3) The storage and measurement capability is strong, and 11 parameters can be measured in real time to assist in determining the working status of the tool in the wellbore. It can not only ensure the technical requirements for construction, ensure the safety of downhole tools during the drilling process, but also store all the data in the instrument and return it on the ground after the service ends to reproduce the entire drilling process.

3.3 Near-bit CGDS-LWD system

3.3.1 The structure

The CGDS- LWD near-bit geolocation drilling system consists of measuring and transmitting motor, wireless receiving system, MWD positive pulse wireless tracking measurement system and ground information processing and guidance decision-making software system.

3.3.2 The working principle

The short section of near bit in the measuring and transmitting motor can measure the bit resistivity, azimuth resistivity, azimuth gamma-ray, well inclination, temperature and other parameters. The measurement parameters of the near bit are transmitted to the wireless short transmission receiving system above the bypass valve by electromagnetic short transmission. Connect to MWD on the wireless receiving system, and connect to the transmitting motor under it. Receive the electromagnetic signal emitted by the wireless short transmission transmitting coil under the motor and integrate the short transmission data into the MWD system by the upper data connection assembly. MWD positive pulse wireless tracking measurement system includes MWD downhole instrument and MWD ground equipment. Both through the drill string in the mud pressure pulse signals of channel for communication, and coordination, implement drilling in the state of the downhole tool, the downhole working conditions and related measurement parameters (including directional hole deviation and azimuth, tool surface parameters, gamma, resistivity, such as geological parameters, and other engineering parameters such as drilling pressure, torque) of real-time monitoring. Ground application system can be in the process of drilling real-time uploaded near-bit resistivity, natural gamma ray geological parameters, such as processing and analysis, so as to explain the new drilling and formation properties and judgment, and treat drilling stratigraphic guide simulation, according to the engineering parameters of real-time upload again, make the necessary adjustments to borehole trajectory design, to make decisions and control while drilling, which can improve the exploration Wells and development Wells in the reservoir drilling rate and drilling success rate.

3.4 MRC near-bit geological guidance system

3.4.1 The structure

The MRC near-bit geological guidance system mainly includes oblique gamma ray measurement system of near-bit well, electromagnetic resistivity measurement system of drilling along with electromagnetic waves, interconnection system of high speed bus, and MWD wireless tracking measurement system.

3.4.2 The working principle

The whole system adopts the design of multi-parameter compact depth for multi-frequency electromagnetic wave resistivity measuring instrument as the core, natural gamma ray adopt bearing structure design, logging tools, near-bit structure design is used, the azimuth gamma, near-bit deviation, the structure of the electromagnetic wave resistivity integration on 1 drill collar, connected to the power tool, behind the MWDS measuring instrument, the engineering parameters (deviation and azimuth), geological parameters (depth of electromagnetic wave

resistivity and gamma ray) and near-bit deviation integrated design. At the same time, the dynamic azimuth gamma-ray measurement can be realized by adding a rotating azimuth measurement module to conduct sector statistics of the natural gamma counting rate. Compared with the existing technology, MRC near-bit geological system can be realized at the same time near-bit gamma and different depth of the probe resistivity measurement of azimuth, take the initiative to adjust the well track, reduce the risk of playing in reservoir, increase the drill encounter rate and recovery factor of oil and gas reservoir.

4. DOWNHOLE DATA TRANSMISSION MODE OF NEAR-BIT MEASUREMENT SYSTEM

4.1 Acoustic measurement system with drilling

Acoustic transmission is the use of sound waves to transmit logging signals. Its main principles and devices are: First of all, to the location on the bit to install a control device which is pinger, and then obtain the parameters of the underground, through the MWD system sensor, to obtain the parameters of the used in the form of modulation and coding and binary conversion, forming a set of acoustic pulse signal, and then using the launcher will be launch, this set of acoustic pulse signal and the pulse signal transmission through the drill pipe to receiving device, the final receiver received the pulse signal amplification, demodulation and filtering processing, get the downhole measured parameters.

4.2 Mud pulse measurement system with drilling

The mud pulse transmission method USES the mud in the drill pipe as the transmission medium to transmit the signal. In the pulse tracking measurement system, the most important component is the pulse device. The working principle of this system is: First to obtain the parameters of the underground, then by the downhole sensor to encode parameters, encoded signal carried by drill pipe in the mud, transmitted along the pipe, in the process of transmission, mud pulse impact driven rotary valve opening or closing and rotor, to produce a variety of mud flow direction, the mud in a drill pipe to produce a range of different pressure pulse, the encoded signal transmission to the receiver, the receiver received signal filtering, decoding, such as processing, get the downhole measured parameters. MWD is the most important technical means to obtain downhole information. At present, this technology is widely used in the drilling of large-displacement horizontal Wells and directional inclined Wells in various oilfields in China, and has achieved remarkable results, which has greatly improved the drilling penetration rate of oil and gas Wells.

4.3 Electromagnetic tracking measurement system

Electromagnetic Measurement While Drilling (EM-MWD), While Drilling USES Electromagnetic waves to transmit signals. Its principle is: First to obtain the parameters of the subsurface, transform to obtain the parameters of the appropriate modulation method is adopted to improve the modulation, which is the parameter to the carrier, and then the modulated signal from the transmitting antenna to launch out around him, and transmitted by wireless transmission medium, such as drill pipe or strata to the receiver, the receiver received

modulated signal is amplified, demodulation and filtering processing, get the downhole measured parameters.

5. APPLICATION OF NEAR BIT TECHNOLOGY

5.1 Fuling district

At present, in the application of the conventional guidance instrument in fuling work area, the distance between the measuring point and the bottom of the well is large, and the maximum measurement cannot be achieved. The measurement point of near-bit geological guidance system is close to the drill bit, which can further improve the control precision of borehole trajectory. In the process of the target, near-bit geological technology give full play to the characteristics of the blind area is short, to the field engineers judgment in time horizon, adjust the well track provides enough space, to ensure the access to a target.

In the process of horizontal section of the guide, the technicians can text is set to judge bit position marked top boundary layer, by adjusting drilling parameters to achieve increased oblique, fall or stabilization, the purpose of smooth borehole trajectory as far as possible. This technique can detect the formation changes in time and provide accurate data for the correct understanding of the formation. Technicians can timely guide and adjust borehole trajectory according to drilling data to improve the drilling rate of high-quality shale gas layers. Near-bit geological technology can effectively achieve real-time geological drilling, to complex underground structure, stratigraphic occurrence, thin layer of oil and gas or uncertainties wellbore trajectory control is difficult areas such as oil and gas to provide strong technical support.

5.2 Shengli oilfield

Actual drilling data of a well in Shengli oilfield. Although engineers with the knowledge of formation and past experience has no significant adjustments of borehole trajectory, but using the same BHA in the same formation of compound drilling cases appeared different borehole trajectory. When measuring hole depth of 4008.29 m, measured deviation is 90.6 °. Thanks to survey the length, the bottom hole is expected (4020 m) hole depth hole deviation to nearly 91 °, keep horizontal drilling needs to slide down inclined drilling or adjusting drilling parameters, and then at the bottom of the well actual hole deviation has a downward trend, reached 89.7 °, if carried out in accordance with the usual practice sliding down inclined homework at this time, is 4018 m depth of hole deviation will be further reduced. A great deal of field practice has proved that even in horizontal drilling with consistent lithology and large thickness, there are a lot of construction risks. Therefore, if the explanation with drilling technology to drilling geological characteristics of strata has a guiding significance to the given information, provide a reference for field directional engineer accurate judgment, is the risk of miscalculation well track development trend will be greatly reduced.

Of course, the above problems can be solved by measuring the deviation of near bit well with drilling. This is also the inevitable trend of the development of geology-oriented technology. However, it is worth paying attention to the problem that the data upload rate of some blocks

in Shengli oilfield is insufficient. For example, the mechanical drilling speed of shallow horizontal Wells in isolated islands, Caoqiao and other areas can reach 30m/h or even 50m/h when drilling horizontally. In this case, it is not suitable to use underground equipment with too much data uploaded with drilling. Besides near-bit deviation and azimuth gamma MWD equipment, need to install the motor above the amount and type of MWD tool for optimizing, and take the necessary engineering support measures, avoid measurement information collection during drilling problems affecting the quality of construction.

6. CONCLUSIONS AND SUGGESTIONS

(1) Real-time acquisition underground strata information, accurate and timely reflect underground true physical, combined with logging data to complete real-time formation evaluation, the stratigraphic classification more reasonable, the reservoir porosity and fluid types of discrimination is more scientific, etc.
(2) The near-bit geological guidance system finds the reservoir earlier than the conventional LWD guide tool to improve the drilling rate. Real-time judgment and decision-making capability is superior to LWD.
(3) Near-bit geological drilling system real-time monitoring near-bit resistivity, azimuthal resistivity, natural gamma ray data, near-bit deviation and the surface of the lateral resistivity data, such as judging bit position in reservoir, and adjust the drill bit, drilling in the reservoir.
(4) The technology can be widely used in horizontal well (especially poor thin reservoir horizontal Wells), the large displacement Wells, branch Wells, the lateral drilling and fishbone Wells, can improve the judgment of stratum structure, reservoir characteristics and reservoir in wellbore trajectory control accuracy, thus improve the sandstone drilling rate.

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