

Beijing Liuhe Greatness Technology co., Ltd.

Technology Quarterly

Iss 2, Aug. 30th, 2019

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New R&D Product Introduction

Formation Pressure Measurement While Drilling System

Overview

Formation pressure refers to the pressure acting on the fluid in the formation pore space. Formation Pressure Measurement While Drilling System is to obtain the data of formation pressure at the same time of drilling. The measurement technology is the important component of advanced intelligent drilling technology, which is of significance.

In the process of pumping formation fluid, the domestic formation pressure measuring instrument does not optimize the pumping rate, pressure drop and pressure recovery time for the formation with different lithology, high fluidity and low permeability, which may lead to inaccurate data during the measurement. The formation pressure measuring instrument of our company is optimized on the formation fluid suction model, which improves the measurement accuracy and also optimizes the measurement time.

Features

- ◆ Intelligent measurement can be made according to different formation fluidity to improve the measurement accuracy and optimize the measurement time.
- ◆ Push force can be set to ensure the push seal while saving power.
- ◆ Temperature is 175°C and pressure is 150MPa, suitable for high temperature and high pressure measurement while drilling.
- ◆ It can detect annulus pressure in real-time, and timely know downhole pressure information.
- ◆ Reliability design. It can timely retrieve the probe in case of unexpected power failure, and reduce the risk of downhole operation.

Application

- ◆ Formation Evaluation
 - Establish formation pressure gradient
 - Search for reservoir information
 - Reservoir pressure management
- ◆ Drilling Optimization and Safety
 - Pore pressure check
 - Reduce cost and risk, improve drilling efficiency
 - Monitor annular pressure in real time
- ◆ Geosteering and Geological stop drilling
 - Rapid identification of closed faults and reservoir connectivity, and avoidance of drilling in pressure-depleted reservoirs.
 - Help decision makers select the best production zone for drilling and determine the optimal drainage length for horizontal wells.



New R&D Product Introduction

Downhole Multi-function Sub

Overview

The bottom-mounted MWD instrument is a kind of wireless drilling instrument widely used at present. As a steering instrument for directional wells, it can measure the trajectory parameters (inclination, azimuth, tool surface angle, etc.) in real time while drilling, which greatly improves the trajectory control ability. However, due to the installation method, there are the following defects:

- ◆ There is no constraint on the top of tool string, and the measurement stability and reliability are poor.
- ◆ The downhole vibration and impact are large, which will cause frequent disconnection of the instrument.
- ◆ It is difficult to fish MWD instrument after the lower male thread of the non-magnetic drill collar breaks.
- ◆ The application of drilling instrument in horizontal well is poor.

Based on the above factors, in order to make the bottom-mounted MWD instruments have wider application space, the equipment is designed to be installed in the top end of downhole tool string. It can push the three backup blocks tightly against the non-magnetic drill collar wall to reduce the vibration and improve the measurement stability and reliability. In addition, after the lower male thread of the non-magnetic drill collar breaks, it can make MWD instrument fished together with non-magnetic drill collar.

Features

- ◆ The instrument is short, easy to assemble and disassemble
- ◆ The push and recovery of the three push blocks are controllable
- ◆ Fishing is convenient, and do not affect the normal drilling
- ◆ It can be used for non-magnetic drill collars with different inner hole diameters

Application

It is used instead of fishing head together with bottom-mounted MWD, and it can make tool push tightly against the non-magnetic drill collar to reduce the tool string vibration and to improve the measurement stability and reliability, prevent to disconnection. It also can improve the reliability of MWD used in horizontal well drilling.



New R&D Product Introduction

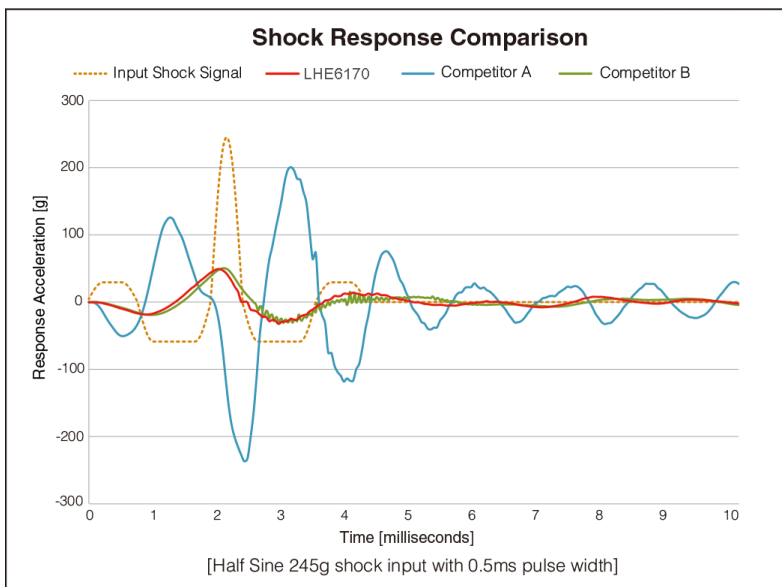
Downhole Vibration Absorption Sub

Overview

Now in the oil drilling process, MWD is hardwired to the directional drill collar, so there is no vibration absorption device. In the aggressive drilling environment, it is easy to increase the impact on MWD vibration and impact, so as to increase the maintenance cost and reduce the instrument life.

Features

- ◆ The MWD dynamic measurement accuracy has been greatly improved
- ◆ Effectively alleviate the axial and lateral impact and vibration
- ◆ Can be repeatedly disassembled and assembled
- ◆ Increase the MWD mud pulse amplitude
- ◆ Reduce wear and prolong the maintenance times and service life of the pulser
- ◆ Temperature is 165 °C and pressure is 138MPa
- ◆ Allow a wider range of flow



Application

- ◆ MWD downhole vibration absorption sub LHE6170 reduces the vibration caused by downhole use, reduces the failure rate of the instrument, reduces the maintenance cost, and prolongs the instrument life;
- ◆ MWD vibration absorption sub LHE6170 can make the instrument stable in a certain frequency range, ensure the stability of the instrument signal, and improve the instrument precision.

New R&D Product Introduction

Well Control Electronic Guard Management System

Overview

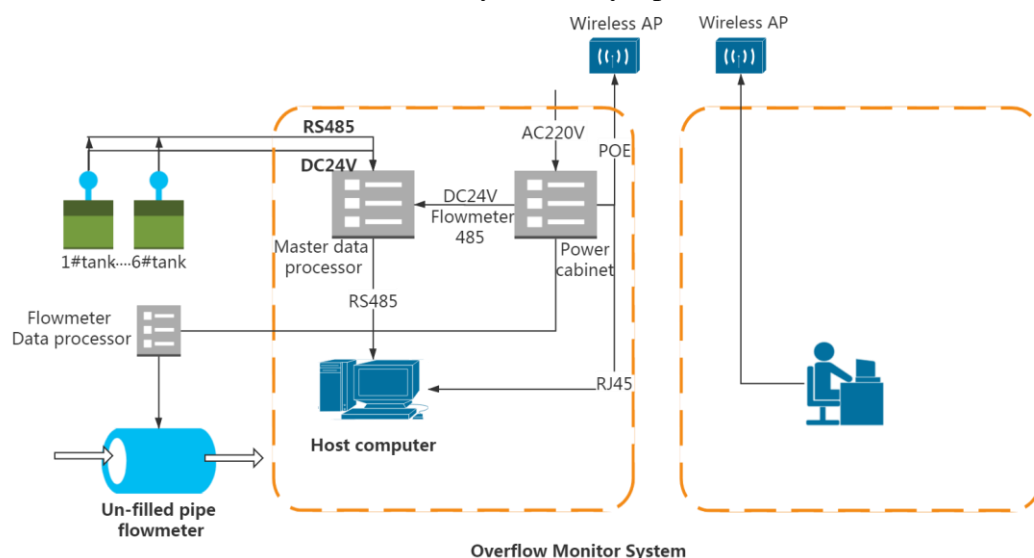
In drilling operation, blowout and well leakage will not only affect the normal drilling schedule, but also cause various safety accidents. At present, the volume of drilling fluid and mud outlet flow data of grouting tank are recorded manually in each oilfield to judge and detect blowout and well leakage, but the workload is relatively large and there is data deviation.

Well Control Electronic Guard Management System adopts the most advanced electronic detection instrument to monitor and judge the occurrence of blowout or well leakage in real time. If any abnormal phenomena are found, the watchkeeper shall be timely alerted through the software interface and the form of external sound and light alarm to prevent further expansion of the problem and reduce losses.

Features

- ◆ The non-full tube electromagnetic flowmeter is used to monitor the mud flow rate and mud height in the pipeline in real time. The actual flow rate is calculated to ensure the accuracy of pipeline mud flow
- ◆ The change of mud level can be calculated in real time by using ultrasonic liquid level meter to monitor the change of mud level in the tank in real time.
- ◆ Using wireless transmission technology, the computer desktop data of the system can be displayed on the technician's computer desktop across the network bridge.
- ◆ With sound and light alarm device, ensure the timely and eye-catching abnormal alarm.

Therefore, the product has the characteristics of stability, accuracy, speed and less labor.



Application

Solve the problem of large manual recording workload and easy data deviation, reduce labor cost, avoid errors, and timely find well leakage, overflow and other abnormal phenomena, to prevent production safety accidents.

New R&D Product Introduction

Ø38mm Slim-hole MWD

Overview

As the current drilling depth increases, the temperature, pressure, flow rate, mud density and complexity of the corresponding downhole conditions all increase synchronously. As the depth of the well increases, the need for small diameter instruments becomes more and more urgent. In this case, the company develops Ø38mm MWD.

Features

- ◆ The outside diameter is $\Phi 38$ mm, temperature is $175\text{ }^{\circ}\text{C}$ and pressure 172 Mpa. In slim-hole construction, $\Phi 88.9$ mm standard non-magnetic drill collar (inner diameter is $\Phi 50$ mm) can meet the normal use of the instrument. There is no need to enlarge water hole of non-magnetic drill tool, thus improve the security of downhole drilling tools.
- ◆ The pulser adopts the structure of piston-type to dynamically compensate the balance between internal and external pressure of the instrument, so as to enhance the working stability of the instrument.
- ◆ Use motor rotation drive instead of electromagnetic valve. Pull up force is greater.
- ◆ Each sub is connected with the aviation plug $-55 \sim +175\text{ }^{\circ}\text{C}$ of American aerospace standard, which has high insulation and has zero influence on the probe precision.



Application

- ◆ When drilling in deep wells, the hole size is small and the non-magnetic water hole is small. It is necessary to enlarge the hole of non-magnetic drilling tool before putting it into the drilling equipment. There are safety risks after enlarge hole non-magnetic.
- ◆ In case of underground high temperature and high pressure, sometimes it is necessary to rent foreign instruments. The cost of renting this product is relatively high. Compared with foreign products, the use cost of this product is reduced.

New R&D Product Introduction

Radical Drilling Solution

Overview

"Radical drilling" technology, according to the drilling team's machine and pump conditions, select supporting tools such as drill bit, motor, weighted drill pipe and spherical centralizer, and on the premise of ensuring the ability to control the trajectory of the well, enhance and adjust drilling pressure, rotation speed, flow rate and other parameters to achieve drilling speed. Radical drilling technology is very mature in foreign shale gas development. In the "high WOB, high speed, high pump pressure" drilling mode, strengthen the optimization of drilling parameters, greatly improve the production efficiency and reduce the production cost.

Due to the complexity of the terrain, to adopt the same radical drilling technology will bring the whole drilling construction of increasing difficulty. Downhole drill bit, BHA and drilling tool are of influence which is much larger than abroad. "high WOB, high speed, high pump pressure" drilling mode bring with the downhole high vibration, large washout. It is especially striking in the past two years. In the face of domestic oilfield development strategy, as drilling-equipment manufacturers must follow the pace of the scene, make corresponding strategies to improve, to truly promote the full range of radical drilling, to really realize drilling speed in the domestic market.

Application

■ Solve washout problem

- ◆ The most intuitive is to improve the material. In the face of radical drilling, select imported materials of the same type;
- ◆ Improve the flow path, increase the inner diameter space of the drill collar. Promote more slim-hole tools, and increase the flow area;
- ◆ Improve the structure design of the instrument, reduce the moving parts, adopt the spraying technology for the parts directly facing the erosion;

■ Solve vibration problem

- ◆ In the face of radical drilling, the downhole vibration absorption sub are recommended to reduce downhole vibration acceleration.
- ◆ Improve the vibration reduction inside the instrument, increase the sensor vibration reduction coil, eliminate the resonance problem caused by radical drilling;
- ◆ Improve the quality of domestic sensors, such as quartz accelerometer;

■ Solve signal stability problem

- ◆ In the case of high vibration and high flow rate, the instrument runner design is improved, and the previous round hole design is changed to strip gap design to reduce the entry of large particles, avoid sand-jam, and reduce the parameter changes caused by wear, which results in unstable signals.
- ◆ Optimize the design of surface software and truly realize the adaptive decoding threshold to greatly improve the quality of decoded signals.

- ◆ The problem of performance and stability variation caused by spring failure of magnetic valve pulser is solved by motor driven pulser.

■ **Solve system problem**

- ◆ Overseas "radical drilling" technology has been accelerated to achieve informatization, integration, automation closed-loop drilling technology;
- ◆ Oil field and instrument manufacturers specify criteria for radical drilling conditions to equip with appropriate monitoring equipment and anticipate risks in advance;
- ◆ It is necessary to realize the life cycle management system as soon as possible, which is information management. Record the working time under different temperature, vibration and other environments. Do preventive maintenance in advance to ensure the continuity of radical drilling and reduce the occurrence of accidents.

Engineering Change

Engineering Change

Structure Change

1. LHE6150A Drilling Dynamic Monitor Structure Upgrade

Version upgrade: from c to d

Solution: Add stress relief slot, reduce stress concentration point and increase product stability.

Product Upgrade

2. LHE1137B Gyro Battery Pack Structure Upgrade

Version upgrade: a

Solution: Battery connection mode is changed to screw fastening to facilitate customers to replace batteries on site.

Product Upgrade

Firmware Change

1.LHE6518-20.304 175℃ high temperature Probe firmware reprogramming upgrade

Version upgrade: from V1.0.7 to V1.0.8

Solution: The stability of the instrument is increased, and the static sequence can be acquired under bad working conditions.

Must Do

2. LHE6118-20.304 125℃ Probe firmware reprogramming upgrade

Version upgrade: from V1.0.3 to V1.0.4

Solution: The stability of the instrument is increased, and the static sequence can be acquired under bad working conditions.

Must Do

3. DEES-deep earth exploration system Setup.303 Software Upgrade

Version upgrade: from V1.0.0 to V1.1.0

New features:

- ◆ Plotting function of resistivity decoding data and storing data.
- ◆ Azimuthal gamma (Probe-based) machine function, including the plotting.
- ◆ Add function of manually changing frequency, knowing the current frequency point and target frequency point of the equipment can achieve immediate frequency change.
- ◆ Add network north angle calculation function.

Product Upgrade

Azimuthal Gamma (Probe-based)

Introduction

Azimuthal Gamma Probe-based can realize the detection of formation lithology while drilling, especially maintain borehole trajectory within the target reservoir in horizontal-drilling. It can provide for interpretation of the shale reservoir's organic richness and clay content, identify the top or bottom boundary in CBM. Azimuthal Gamma Probe-based is particularly valuable in unconventional reservoir well placement and evaluation as well as CBM drilling applications.

Case

- ◆ **Date:** July 2019
- ◆ **Place:** QinShui Town, JinCheng City, Shanxi Province
- ◆ **Crew:** XI 2
- ◆ **Well No. :** CZBL-21
- ◆ **Tool No. :** LHE6149 Azimuthal Gamma (Probe-based)
- ◆ **Description:**

Work Period: July 18th –July 25th, 2019

Working hours: 8 Days

Tracking depth: 1745m

Max. Downhole Circulating Temp. : 73℃

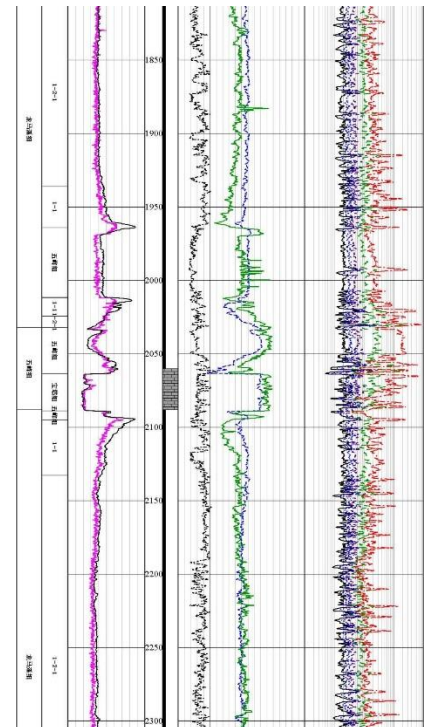
Mud density: 1.85

Standard Pump Pressure: 13.21Mpa

Inclination: 91.21

- ◆ **Conclusion:**

During the test, LHE6149 Azimuthal Gamma (Probe-based) performed normally and stably. Data can be transmitted in real time. Data of top and bottom gamma is stable. Trend is correct. It can accurately steer.



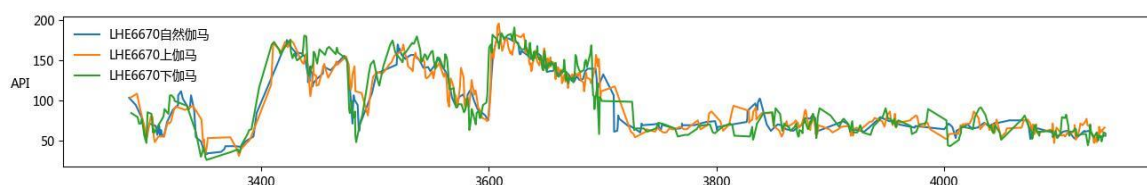
Application Cases

Azimuthal Gamma (Collar-based)

Introduction

At present, most of the azimuth gamma detection instruments in practical application belong to the probe-based azimuthal gamma. The ray from the formation will attenuate to some extent when passing through the drill tool, resulting in weak measurement signal. The drill collar-based azimuthal gamma contacts the formation directly, which makes the measurement signal stronger and the top and bottom gamma resolution is obvious, which can accurately locate the position of oil reservoir and improve the exploitation and utilization of oil resources more effectively.

Case



- ◆ **Date:** June 2019
- ◆ **Place:** Yijinhuoluo Banner, Erdos City, Inner Mongolia
- ◆ **Crew:** ChuanQing 40564
- ◆ **Well No. :** Sudong 43-49XH2
- ◆ **Tool No. :** LHE6670 Azimuthal Gamma (Collar-based)
- ◆ **Description:**
Work Period: June 15th-June 29th, 2019
Working hours: 15 Days
Tracking depth: 3060m-4141.10m
Max. Downhole Circulating Temp. : 89℃



◆ **Conclusion:**

1. This test effectively verify the stable performance and valid data. Gamma value measured in June 22nd and June 24th is in consistent with lithology, which fast and accurately judge the thickness and position of reservoir in the following geosteering.
2. It is easy to operate and widely applicable to instruments. It only needs to configure the receiving sub in the pulse to decode the value through wireless transmission.
3. The software operation process is fast, simple and free of tedious settings.
4. The battery pack lasts for a long time, and the accumulative usage of this time is more than 270 hours (not reaching the limit), which reduces the number of times of POOH and improves the drilling efficiency.

Application Cases

Near-bit Measurement System

Introduction

Now, in the petroleum drilling engineering, conventional systems place image gamma and inclination sensors far behind the bit resulting in a delay in lithological response time. And the geological teams can't locate optimal reservoirs and adjust the geosteering timely. It is difficult to discover shale sandwich timely, increasing chances of drilling out of zone in horizontal drilling, and the geosteering must be adjusted frequently, which will lead tortuosity. However, near bit inclination acquires gamma and inclination dynamically and accurately, which will make up the shortcomings of the geosteering conventional gamma tool.

Case

- ◆ **Date:** July 2019
- ◆ **Place:** Karamay
- ◆ **Crew:** 30632
- ◆ **Well No. :** 1D1236
- ◆ **Tool No. :** LHE774501 Near-bit+LHE6101MWD
- ◆ **Description:**
 - Work Period:** July 28th –July 30th, 2019
 - Working hours:** 3 Days
 - Tracking depth:** 392m-776m
 - Max. Downhole Circulating Temp. :** 60℃
- ◆ **Conclusion:**

The Near-bit system perform well. Compared to other tools, the system can realize near-bit measurement, shorten inclination distance, reduce difficulty of adjusting trajectory and make azimuthal gamma predict in advance. Communication across motor is normal. Azimuthal gamma and static inclination data are normal.



Application Cases

LWD Resistivity Measuring System

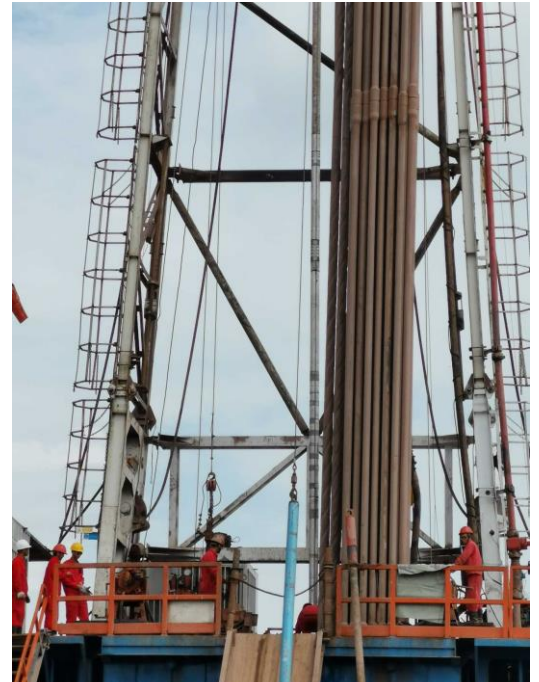
Introduction

The system is based on magnetic field theory, adopt 2M and 400k frequency, measure the amplitude ratio and phase difference of the coil received in difference formation, and convert to get the resistivity information. This instrument can greatly enhance the detecting efficiency and provide technical support for exploiting complicated oil formation.

Case

- ◆ **Date:** Aug. 2019
- ◆ **Place:** Lishi Town, LuZhou City, SiChuan Province
- ◆ **Crew:** 40518
- ◆ **Well No. :** YunJin 1
- ◆ **Tool No. :** LHE7310B Integrated Resistivity
- ◆ **Description:**
 - Work Period:** July 25th –Aug. 11th, 2019
 - Working hours:** 339h
 - Tracking depth:** 1470m-3083m
 - Max. Downhole Circulating Temp. :** 95℃
- ◆ **Conclusion:**

1. During the period, downhole resistivity keeps stable performance. And surface software is reliable.
 2. The resistivity system satisfy the requirements while drilling and provide geosteering data.
- The test is successful.



Application Cases

Wireless Measurement While Drilling

Introduction

Wireless Measurement While Drilling (MWD) adopts mature and reliable positive pulse technology. It transmits stand pipe signals and other data by radio on the ground. There is no need to lay out cables, which make it easy and convenient for operation. Magnetic coupling communication is used between downhole subs, which is easy for connection, which solve the hidden trouble caused by the traditional pin structure in the process of vibration. The data process software could decode and display downhole parameters. The MWD could be used under max. 175°C downhole temperature.

125°C MWD is accumulated to sell hundreds of strings and 175°C MWD is to sell tens of strings till 2018. It is mainly used in the deep well of XingJiang and SiChuan.

Case

- ◆ **Date:** Aug. 2019
- ◆ **Place:** WuSu City, Xinjiang Uygur Autonomous Region
- ◆ **Crew:** 70207
- ◆ **Well No. :** GAO 02
- ◆ **Tool No. :** LHE6400 150°C MWD
- ◆ **Description:**

Work Period: April 23rd – Aug. 6th, 2019

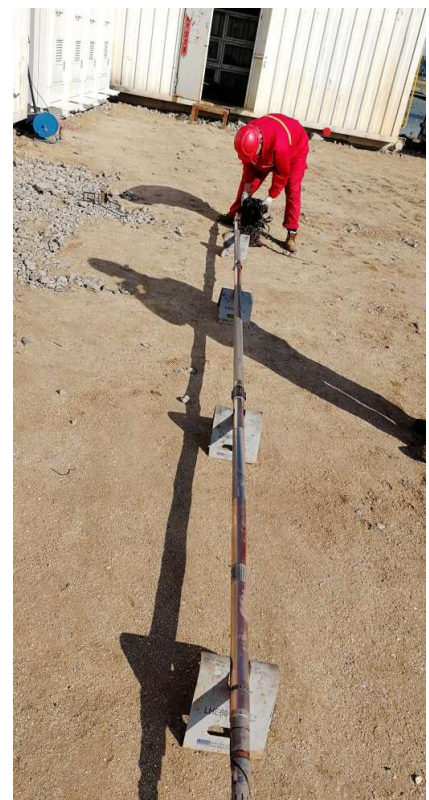
Working hours: 76 Days

Tracking depth: 2nd spud-in: 500m-1800m ,
3rd spud-in: 2800m-4905m

Max. Downhole Circulating Temp. : 125°C

- ◆ **Conclusion:**

It performs and decode stably in HTHP well located in Nanyuan block. Inclination and other data are accurate.



Application Cases

Slim-hole Wireless Measurement While Drilling

Introduction

When drilling, the inner diameter of downhole BHA becomes smaller along with well depth. Conventional Ø48mm MWD can not be used. Higher pressure and smaller diameter MWD is needed. LiuHe release the reliable Ø38mm MWD to meet field application.

Case

- ◆ **Date:** July 2019
- ◆ **Place:** Wushen, SuLiDe
- ◆ **Crew:** 40620
- ◆ **Well No. :** TAO 2-22-7CH
- ◆ **Tool No. :** LHE6201 150℃ Slim-hole MWD
- ◆ **Description:**
 - Work Period:** June 3rd –July 3rd, 2019
 - Working hours:** 31 Days
 - Tracking depth:** 3050m-4265.3m
 - Max. Downhole Circulating Temp. :** 120℃
 - Max. Downhole Pressure:** 72MPa
- ◆ **Conclusion:**

The 150℃ MWD is accumulated to work 31 days and track depth from 3050m to 4265m, and Max. downhole circulating temperature is about 120℃. The well is casing window-opened horizontal gas well. It do not cause POOH by the tool and the tool works stably with reliable performance.



Application Cases

Wireless Communication Surface System

Introduction

In drilling engineering, MWD surface system usually need to be connected by cable, which may cause many problems such as car rolling, cable cutting, or connection distance is less than the length of the attached cable.

Signal transmission and wireless transmission technology have been applied in the industrial production process. Wireless Communication Surface technology can carry out signal conversion and restoration. To achieve signal transmission, it can be upgraded in the existing MWD surface system to save the laying and maintenance of on-site cables. It is of long transmission distance and provide convenience for on-site construction.

Case

- ◆ **Date:** July 2019
- ◆ **Place:** WuShenzhao Town, WuShen Qi
- ◆ **Crew:** 40909
- ◆ **Well No. :** Sudong19-34H1
- ◆ **Tool No. :** Wireless Communication Surface system
- ◆ **Description:**
 - Work Period:** June 23rd –July 10th, 2019
 - Working hours:** 18 Days
 - Tracking depth:** 500m-3261.71m
- ◆ **Conclusion:**



During the test, the system is easy for assembly. Data is stable. Real time data could be normally transmitted. It is compatible with depth system. The tool perform stably and upload data accurately. The test is successful.

The Wireless Communication Surface System could converse and restore signal to realize signal transmission. It is also compatible with tools from other manufactures.

Application Cases

Rotary Pulser MWD

Introduction

The high-power brushless motor used in MWD-Rotary Valve System can cut and remove the big size LCM (Lost Circulation Materials) particle for easier pass in drilling fluid channel. Anti-interference is designed carefully and scientifically, with Positive Mud Pulse for data transmission. Then the System has been getting a great improvement on avoiding signal interference and valve head blocking. That is why Rotary Pulser MWD can satisfy various mud weight and downhole conditions.

Case

- ◆ **Date:** May 2019
- ◆ **Place:** DongYing Shengli Oilfield
- ◆ **Crew:** Chuanqing 70120
- ◆ **Well No.:** ShuangTan No.18
- ◆ **Tool No.:** LHE5616-00 Rotary Pulser
- ◆ **Description:**
 - Work period:** May 14th –May 17th,2019
 - Working hours:** 3 days
 - Tacking depth:** 6500m-6728.41m
 - Max. Downhole Circulating Temp.:** 120℃
- ◆ **Conclusion:**

During the working process, the pulser performs well.
Pulse signal is clear to meet the requirements of filed use.

