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Research on Tools of Deep Well Coiled Tubing Sidetracking at Domestic and Foreign

Xinyi Chen[1], Xiyu Wei[2]

[1]Department of Oil and Natural Gas Engineering, Chongqing University of Science and Technology, Chongqing, Sichuan Province, China
chenxinyi08230415[at]gmail.com

[2]Department of Oil and Natural Gas Engineering, Chongqing University of Science and Technology, Chongqing, Sichuan Province, China
2364388522[at]qq.com

Abstract: ***At present, coiled tubing is used for sidetracking at domestic and foreign. The sidetracking has lots of advantages, such as small footprint, low cost, short time, fast drilling speed, safety and environmentally friendly. It is one of the most advanced drilling technologies today, which is easy to realize automation and intelligence, and can effectively reduce the cost of sidetracking. However, deep well coiled tubing drilling is still in the experimental stage in China. At present, it is difficult for domestic coiled tubing tools to realize sidetracking from a depth of more than 4000m. Therefore, it will have certain research significance to preliminarily determine the tools for deep well CT sidetracking.***

Keywords: Deep well; Coiled tubing; Sidetracking; Tools

1. Introduction

Coiled tubing drilling is usually divided into cableless coiled tubing drilling and cabled coiled tubing drilling according to whether the down hole drilling system is transmitted and controlled by cable. At present, the wireless coiled tubing drilling technology has been widely used by foreign companies for shallow level drilling and deepening of old wells, while wireline coiled tubing is widely used in casing sidetracking horizontal well operations1. However, in China, there still have problems when using cabled coiled tubing for sidetracking. It is difficult to impose WOB and lack of down hole tools to obtain drilling parameters. Therefore, it is imminent to explore the tools and techniques suitable for domestic deep well coiled tubing sidetracking.

Tool assembly for cabled coiled tubing

1.1 Baker Hughes CoilTrak Coiled Tubing Directional Drilling tool assembly

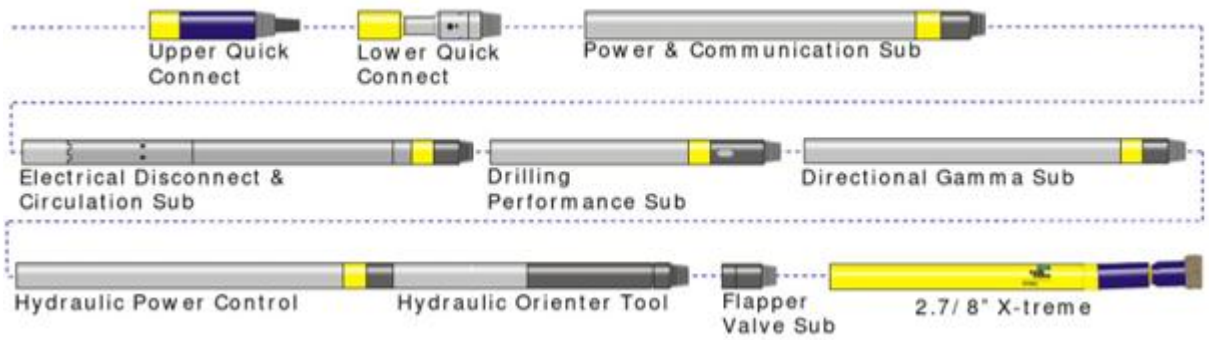


Figure 1: Baker Hughes Coil Trak Coiled Tubing Directional Drilling

The tool combination string is: upper quick connect + lower quick connect + power& communication sub + electrical disconnect & circulation sub + drilling performancesub + directional gamma sub + hydraulic power control + hydraulic orientertool + flapper valve sub + 2.7/8 inX –treme[2]. The tool provides real-time signal transmission through cabled coiled tubing and a maximum build rate of 50 °/100 ft. Its key component is the hydraulic orientertool.

1.2 Baker Hughes CoilTrak coiled tubing resistivity LWD drilling tool assembly

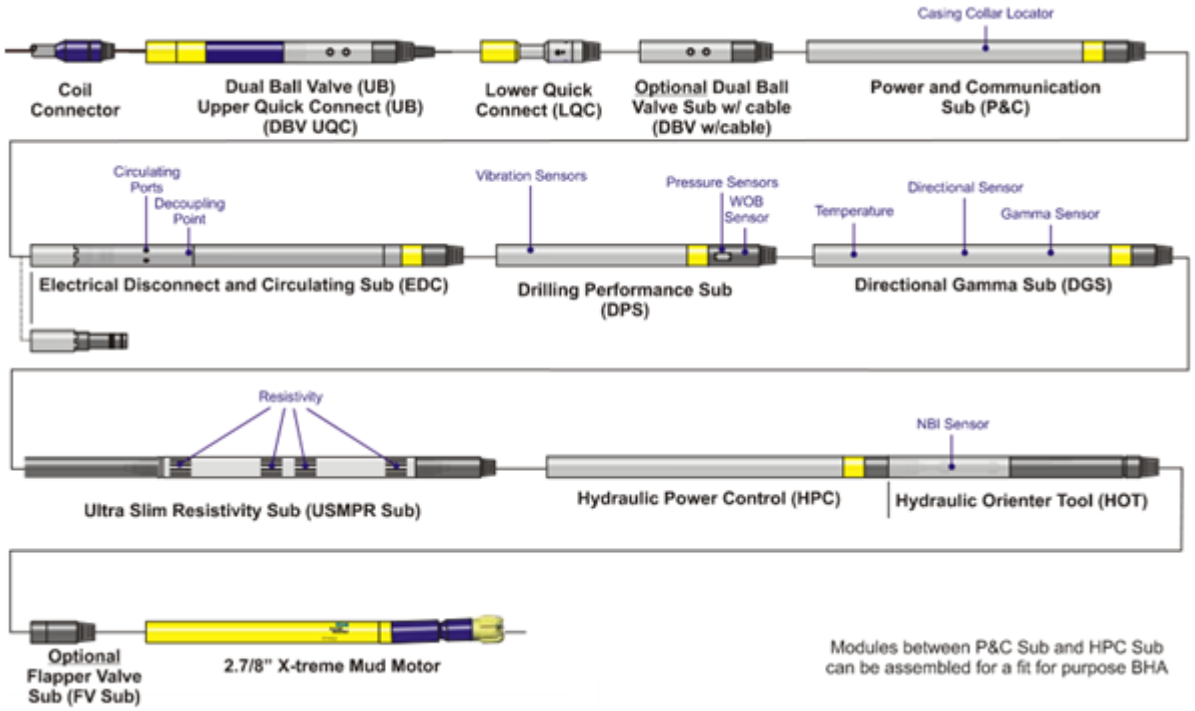


Figure 2: CoilTrak Resistivity LWD BHA

Compared with the tool string shown in Figure 1, this tool string has an ultraslim resistivity sub, which is mainly used for measurement while drilling. It can collect geological parameters and borehole trajectory parameters which can reflect formation characteristics in real time3.

1.3 Baker Hughes CoilTrak-Rib-Steering Automatic Guidance System

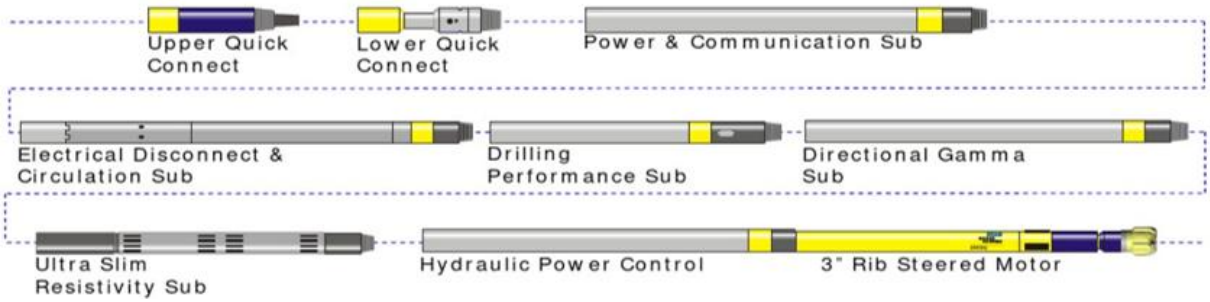


Figure 3: CoilTrak-Rib-Steering Automatic Guidance System

The tool string is the third generation CoilTrak system developed by Baker Hughes[4-5]: upper quick connector + lower quick connect + power and communication sub + electrical disconnect & circulation sub + drilling performance sub + directional gamma sub + ultra slim resistivity sub+ hydraulic power control + 3 in rib steered motor. The key tool is the rib steered motor. The rib steered motor can complete the drilling operation with the minimum dogleg and less friction, which can realize the drilling of long horizontal wells and form a straighter and smoother wellbore.

1.4 Schlumberger Anadrill VIPER coiled tubing sidetrack drill assembly

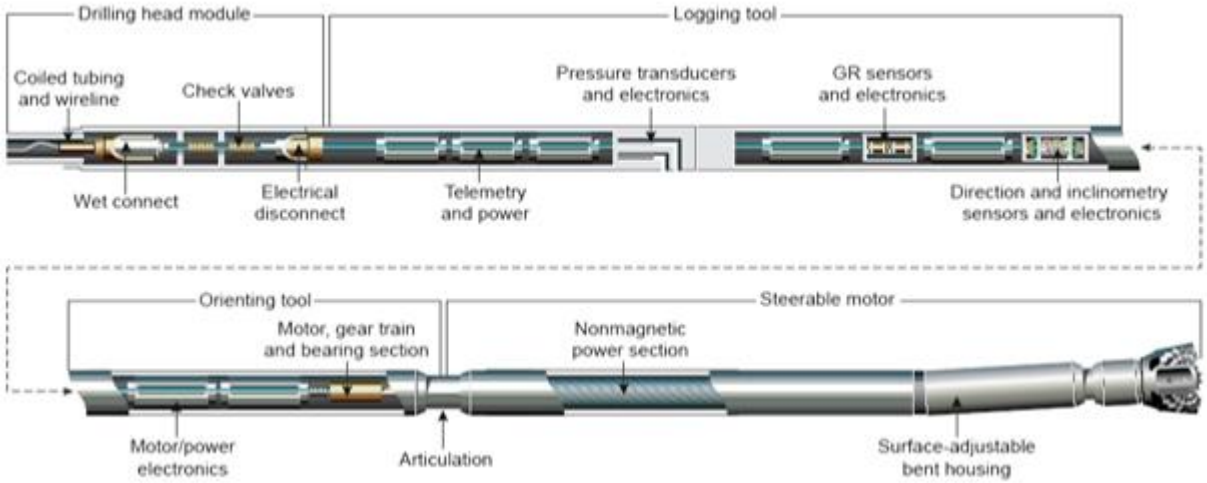


Figure 4: Anadrill VIPER coiled tubing sidetrack drill assembly

The tool combination string is: Coiled Tubing + Cable + Wet connect + Check Valves + Electronical disconnect + Telemetry and power + Pressure transducers and electronics + GR Sensors and electronics + Direction and Inclinometry sensors and electronics + Motor, gear trainand bearing section + Nonmagnetic power section + surface-adjustable bent housing. The tool combination is powered via a cable and has a data transfer rate of up to 100 bit / sec, which is significantly enhanced compared to traditional mud pulse signals (3-6 bit / sec) 6. The torque of the orientator is as high as 1360 N·m, 1r/m and the change value of the orientation accuracy can be as small as 1° , and it can be converted clockwise and counterclockwise in both directions. In addition, the directional device can adjust the tool face during drilling, which means that the position of the drill bit can be changed without lifting the bottom hole assembly, greatly shortens the operation time and can drill straighter and smoother holes.

2. Tool assembly for cableless coiled tubing

2.1 Baker Hughes CoilTrak mud pulse transmission BHA

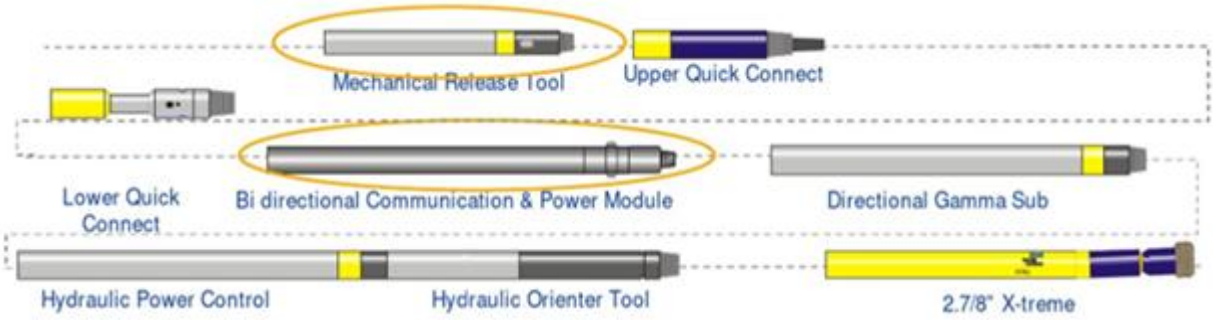


Figure 5: Baker Hughes CoilTrak mud pulse transmission BHA

The tool combination string is: lower quick connector + mechanical release tool + upper quick connector + Bi directional communication and power module + directional gamma sub + hydraulic power control + hydraulic orienter tool + 2-7/8 in X-treme. The drilling tool assembly is wireless and transmits signals through mud pulses, and its maximum drilling slope is 50 ° / 100 ft.

2.2 Supporting tool string developed by China Petroleum Engineering Technology Research Institute

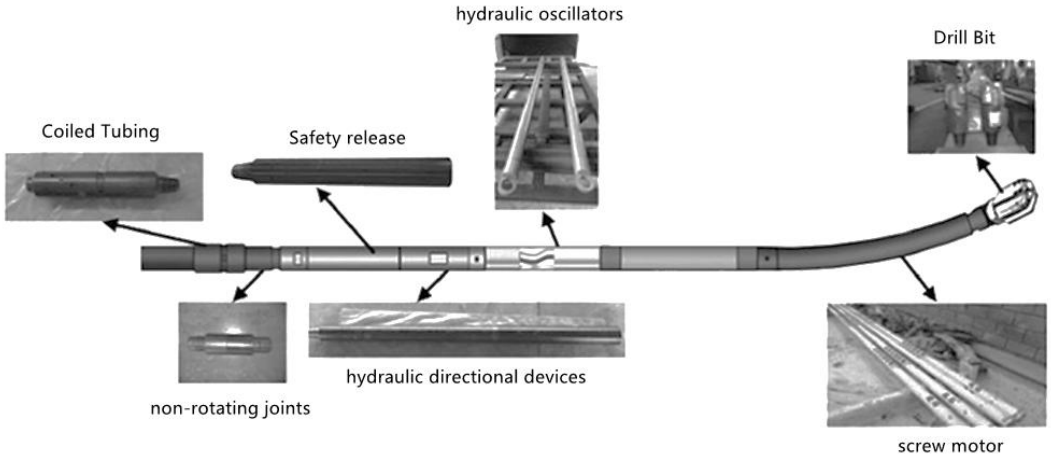
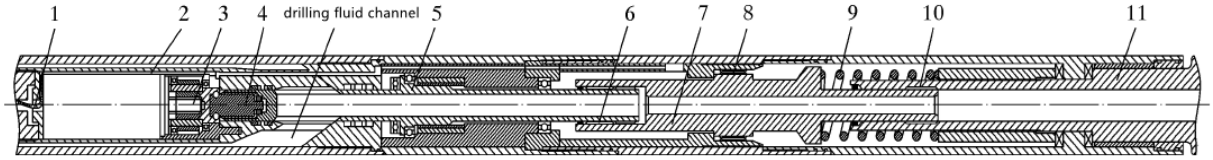


Figure 6: Supporting tool string developed by China Petroleum Engineering Technology Research Institute

The tool string is independently developed by the China Petroleum Engineering and Technology Research Institute. The key components are CT connectors, non-rotating joints, Safety release, hydraulic directional devices[7], hydraulic oscillators, and CT Sidetracking tools. The tool string can be used for CT drilling feasibility test, CT stable-inclined drilling, CT sidetrack drilling, CT directional drilling, CT horizontal well drilling, etc. The deepest operating well depth is 3503.45 m, the longest single well footage is 1010m, and the longest single well horizontal section is 123 m. The electric steering gear adopts high-speed, high-specific power DC motor and electronically controlled direct drive of the large reduction ratio reducer to realize fine adjustment of the downhole tool face. The adjustment angle accuracy is about 1°, and the torque reaches 800-1000 N · m. The cable-while-drilling parameter measurement system transmits signals through cables, and transmits 270 V high-voltage direct current.

2.3 PetroChina Jianghan Machinery Research Institute

CNPC Jianghan Machinery Research Institute has designed coiled tubing drilling electro-hydraulic directional devices with a minimum outer diameter of 85.7 mm and other specifications8. The total length of the orientator is 4m, the outer diameter is 85.7mm, the maximum torque is 1kN•m, the orientation accuracy is ±2.5°, the tool face orientation range is-2000~+2000, and the rotation speed is 1.0°~1.5°/s.



1-cable; 2-micro electric motor; 3-planetary gear mechanism; 4-coupling; 5-hollow drive shaft; 6, 8, 1 0-axial spline; 7-locking sleeve; 9-return spring; 1 1-output shaft

Figure 7: PetroChina Jianghan Machinery Research Institute

1) Overall structural design:

Including power mechanism, transmission mechanism, locking device and output shaft. The power mechanism includes a micro electric motor, which drives the hollow drive shaft to rotate through the transmission mechanism. The transmission mechanism is under the electric motor, and includes a planetary gear mechanism, a coupling, a universal joint and a hollow drive shaft from top to bottom. The locking device is in the hollow drive shaft. The underside of the drive shaft, including the locking sleeve and the return spring, can lock the tool face when the orientation is completed. The output shaft is under the locking device, and the end of the output shaft is connected to the elbow or the bending motor, and the orientation is achieved by rotating the tool face effect.

2) Working principle

During the drilling process, when the angle of the drill bit tool face fails to meet the design requirements, the surface pump pressure is increased through the surface control device, and the drilling fluid passes through the coiled tubing and its downhole tools and enters the liquid flow channel of the directional device, and then flows through the drilling fluid. The locking sleeve, under the action of the pressure difference, pushes the locking sleeve down and enters the directional mode; at the same time, the ground control device transmits power and control signals to the electric motor in the directional device through the cable built in the coiled pipe, and the electric motor is controlled according to the control The command can rotate in both directions, through the coupling and universal joint, the mandrel is driven to rotate through the reduction mechanism; the end of the mandrel is connected with the curved shell, so as to achieve the purpose of adjusting the tool surface and realize the orientation function. When the tool face is adjusted to the expected target, reduce the pump pressure of the ground pump to the normal drilling value range, the pressure difference acting on the locking sleeve is

reduced, and under the action of the return spring, the locking sleeve is pushed up and enters the lock In tight mode, the drill will continue to drill directionally according to the current tool face angle. When you need to adjust the tool face angle again, repeat the "Orientation Mode" and "Lock Mode" operations.

3. Conclusion

In conclusion, China has mastered the preliminary technology of window-side drilling, but there is still a big gap between the exploitation of window-side drilling and horizontal well in deep Wells and foreign countries. The depth of deviated Wells is still around 3000m, while foreign countries have been able to drill up to 6000m, so it is necessary to conduct a lot of research. It is preliminarily determined that the auxiliary tools for deep coiled tubing sidetracking and horizontal well will effectively improve the drilling level of deep and ultra-deep coiled tubing Wells in China. Secondly, the friction of coiled tubing horizontal Wells needs to be further explored to improve the horizontal extension distance of horizontal Wells. Extension tools for related horizontal Wells are also worth exploring to reduce lateral drag and ultimately improve production efficiency.

Acknowledgements

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Author Profile

Chen Xin-yi, born in 1999. Her main research interests include intelligent oil and gas engineering.