Waterway control assembly for rope core drilling rig and its application method

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Abstract. In the process of conventional rope core drilling, the connection and disassembly of waterway occupy a lot of auxiliary time, which seriously affects the drilling efficiency, and even causes drilling or safety accidents. The waterway control assembly and application method for the rope coring rig developed by the author’s team can control the waterway flow direction. It does not need to disassemble the water pipe frequently to control the raising speed of the inner pipe and avoid damaging the drilling tool too fast.

Introduction

1. Introduction
In this paper, in view of the existing core drilling machine technology adaptability, low efficiency problems and practical needs, the project team coring drilling tools for scientific research. The integrated control of the fast switching system of the waterway is developed, and the rope coring waterway control method which is safe, efficient and suitable for the construction of near horizontal hole is developed. The quick change water system can realize the quick change of common drilling conditions, and the cable-connected water joint with buffering function ensures the safety of equipment and personnel during the construction.

2. Format
The characteristic of wireline coring drilling is that when the core is filled with the inner pipe, the inner pipe is fished up from the drill pipe with a wireline fishing tool without lifting the drill to obtain the core. During drilling, water or mud is usually used as the medium to send water to the hole bottom through the path between the water joint and the mud pump. During normal drilling, since the drill pipe is a rotating part. It is necessary to connect the conventional water joint with the drill pipe, and then connect the rubber hose between the water pipe and the mud pump. In the process of conventional rope core drilling, the connection and disassembly of waterways occupy a lot of auxiliary time, which seriously affects the drilling efficiency. At the same time, due to the need to operate the mud pump and drilling rig at the same time, auxiliary mud pump operators have to be equipped, which not only increases the drilling cost, but also makes it difficult for two people to communicate and cooperate in the noisy drilling yard. It affects the drilling efficiency and even causes drilling or safety accidents[1-3].
3. There are problems in the connection of existing waterways
During drilling, water or mud is usually used as the medium to send water to the hole bottom through the path between the water joint and the mud pump. During normal drilling, since the drill pipe is a rotating part, it is necessary to connect the conventional water joint with the drill pipe, and then connect the rubber hose between the water pipe and the mud pump. When fishing the core (mainly horizontal hole or upward hole), it is necessary to put the fishing device into the coring drill pipe, connect the through-line water joint, and then connect the water and mud pump. When fishing the core, it is necessary to disconnect the through-line water joint from the mud pump to discharge the water in the drill pipe. Especially when drilling the upward hole, the inner pipe assembly is fished out under the action of its own weight. In this process, it is necessary to continuously adjust the size of the drain port to adjust the falling speed of the inner pipe assembly and the speed of winding the steel wire rope with the winch. If the drain port is not adjusted in time or the opening is unreasonable, the steel wire rope is wound too fast, which is not conducive to the neat winding of the steel wire rope, and the inner pipe drops faster. It is easy to damage the drilling tool by directly hard hitting the wireline. During the drilling process, it is necessary to frequently replace the connection between the conventional joint and the wireline water joint, especially the connection between the wireline water joint. Because the wireline water joint cannot be connected with the pipeline rotation, when connecting the wireline water joint and the drill pipe, it is necessary to remove the connecting pipe, tighten the water joint and the drill pipe, and then connect the pipeline again. The operation process is cumbersome and time-consuming, and since the mud pump generally has only one water outlet, it is also necessary to disassemble and connect the connecting pipeline when replacing the conventional water connector and through cable water connector. The waterway replacement process accounts for a large part of the auxiliary time. The efficiency of waterway replacement is an important factor affecting the auxiliary time[4-6].

4. New waterway control assembly
The water channel control assembly for core drilling rig consists of rotatable cable water connector, water channel control valve group, conventional water connector and connecting pipeline. The two connectors A and B in the waterway control valve group are respectively connected with the rotatable cable water connector and the conventional water connector through the connecting pipe. Because the rotatable cable water joint can load and unload the water joint without dismantling the connecting pipeline, the step of screwing and unloading the connecting pipeline is reduced, the auxiliary time is shortened and the labor intensity of workers is reduced. At the same time, because the sealing ring (preferably Y-shaped sealing ring) is used between the rotating sleeve and the mandrel, there is a large gap between the sealing ring and the rotating sleeve before the high-pressure water circuit is connected, the rotating sleeve rotates flexibly, and reliable sealing can be ensured when the high-pressure water circuit is connected.

Fig. 1 system composition
The spring installed in the center of the mandrel can avoid hard impact on the through-line water joint during the falling of the inner pipe assembly, so as to achieve the purpose of soft landing, so as to improve the service life of the drilling tool.

The rotatable cable water joint realizes the installation of cable water joint without dismantling the water pipe. The waterway control assembly connects the rotatable through cable water joint, conventional water joint, water inlet pipe and drainage pipe together. By switching the ball valve in the waterway control assembly, the waterway flow direction can be controlled without frequent disassembly of the water pipe. When the inverted hole or horizontal hole is made, the opening of the ball valve III can be adjusted to control the lifting speed of the inner pipe, avoid damaging the drilling tool too fast.

5. Footnotes
The ZDY1200G drilling rig of Xi’an Academy of Coal Sciences, which is equipped with the waterway control assembly of rope coring drilling, has carried out type test in Cangyuan lead zinc mine, Lincang City, Yunnan Province. A total of 4 boreholes have been constructed, including kz19-1301, with a depth of 512.68m, a core recovery rate of 96.8%, and kz19-1302 - 79° rope coring boreholes, with the fastest single day footage of 98.7m, which is the highest single day footage of the company[1]. The drilling rig was used to construct two boreholes in Xunyang mercury antimony mine, Ankang City, Shaanxi Province, with a total footage of 702m. In the process of use, the driller can quickly switch the water system, realize the convenient switching of normal drilling, fish conveying and lifting inner pipe water, save the process of mud pump clutch operation and reduce labor intensity. When lifting the inner pipe, the water path controls the lowering speed of the inner pipe drilling tool through the throttle valve to realize the uniform lifting of the inner pipe and prevent the accelerated falling from damaging the drilling tool.
6. Conclusion
In practical application, the rotatable cable type water can solve the problem that the conventional cable type water cannot rotate when there is a water pipe connected, so the water pipe must be disassembled back and forth. It only needs to replace the water joint as needed, and there is no need to disassemble the connecting water pipe back and forth, which simplifies the operation process, shortens the auxiliary operation time and reduces the labor intensity of workers. The core of the rotatable through cable water joint is provided with a buffer mechanism, which can avoid fishing the inner pipe from falling too fast and damaging the drilling tool due to hard contact when drilling an inclined hole. The waterway control assembly in this patent can easily adjust the water volume and direction of each waterway in drilling to meet the requirements of different drilling procedures. The operation is convenient, and the layout of the waterway control assembly is relatively flexible, It is convenient for the driller to adjust, no additional auxiliary personnel are required, and the staffing is reduced.

References
[1] Fan Dong, Tian Hongliang, Wang Ruize, Chang Jianguo, Lu Feifei, & Zou Zujie et al. (2019). Development of lightweight full hydraulic tunnel core drill. Coal science and technology, v.47; No.541(12), 136-140.
[2] Wang Ruize. (2019). Design and analysis of angle adjustment mechanism of tunnel core drill. Coal mine safety, 50 (02), 115-118
[3] Wei Huanhuan. (2019). Thread strength analysis of high strength rope cored drill pipe joint. Coal mining machinery (3)
[4] Luo Zheng. (2020). Analysis on the development status of rope core construction technology. Building materials and decoration, 000 (002), 217-218
[5] Yang Shaofeng. (2019). Analysis of wireline core drilling technology. China Metal Bulletin (3)
[6] Shi Zhixing. "Analysis of diamond rope core drilling in broken strata." Western Exploration Engineering 022.012 (2010): 36-37
[7] Zhou Yang, et al. "Comprehensive construction method and effect of rope core drilling in broken stratum", China hydraulic society; China Society of hydropower engineering; Water conservancy and hydropower drilling information network; China Water Conservancy Society; China Society of hydropower engineering; Water resources and hydropower drilling information network, 2015
[8] Li Zhimin. "Technology and formula application of small diameter rope core mud." Western Exploration Engineering 31.05 (2019): 55-57