Development and Application of Screw Unlocking Tool for Downhole Directional Drilling with Drilling

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Abstract

During directional drilling in underground coal mine, a large amount of slag accumulated in the hole caused by the instability and collapse of the hole wall leads to the stuck accident. Taking into account the characteristics of drilling technology, the features of supporting drilling rods, the applicability of stratum and the situation of returning slag in the hole, a new type of screw disengaging card tool with drilling is developed. The tool is simple in structure and easy to install. The field test shows that the tool is reasonable in design and can effectively solve the problem of slag sticking in the caving section.

Keywords

Underground directional drilling; broken stratum; sticking accident; releasing tool; spiral slag discharge.

1. Cause Analysis of Directional Drilling Sticking

In directional drilling, there are mainly hole wall collapse drill, shrinkage drill and sediment drill. Therefore, the reasons for the above three types of drilling sticking are mainly as follows: first, due to the ground stress, the local fracture of coal seam and the shrinking neck of mudstone, the imbalance of pressure inside and outside the borehole leads to the instability and collapse of the borehole wall, and the sudden collapse of massive particle drilling cuttings, and the failure to timely discharge the blocked drilling passage. Second, a large amount of drilling slag deposit hole bottom occurs[1]. When a large amount of pumping is used to punch holes, the smaller size of drilling debris fills the gap of a large amount of drilling cuttings, aggravating the blockage of the drilling slag discharge channel and further forming a local "plug", causing drilling stuck. Third, the supporting drill stem of directional drilling is an external flat structure. In the process of compound rotation, the drill pipe cannot stir the drilling cuttings in the hole, and cannot break the large particles of drilling cuttings. In addition, after the drill pipe is stuck, the directional drilling tool in the hole can no longer rotate, and the second accident will be caused by human factors or stratigraphic factors when the strong lifting is adopted.

2. Design of Screw Release Tool with Drilling

(1) To meet the construction requirements of the directional drilling machine, the rotary and clamping device of the drilling machine can be used for clamping up and unloading. The operation is simple and convenient, and it is convenient to pass through the hole through the clamping device of the drilling machine. The maximum external diameter is no more than 75mm.

(2) It is used together with the construction drill pipe. The connection form is consistent with the supporting drill pipe, and the overall anti-torsion strength meets the construction requirements.

(3) The large particle drilling slag at the bottom of the broken sedimentary hole ensures that the dregs discharge channel of the borehole is unobstructed and the signal can be transmitted in two directions at the same time.

2.1 Overall Structural Design

The structure diagram of screw release tool with drilling is shown in figure 1.The device is mainly composed of external pipe, central cable device, Support ring, spring and hard alloy[2]. In order to connect with the central through-rope drill pipe, the overall structure is consistent with that of the drill pipe. In order to realize reliable real-time transmission of signals, a special spiral groove processing equipment is used on the outer surface of thick wall pipe to milling the spiral groove.

Its main parameters are:

(1) After welding alloy outer diameter: Φ 75 mm;

(2) The tube outer diameter: 170 mm Φ;

(3)Torque length: 400 mm;

(4) Specification: 7mm * 7mm * 26mm;

(5) Flows spiral groove width: 22mm, depth: 5mm.

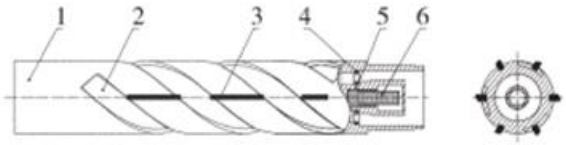

Fig 1. Structure diagram of screw release tool with drilling

2.2 Working Principle and Characteristics

The schematic diagram of working principle of screw release tool with drilling is shown in figure 2.Directional drilling in construction, if encounter broken strata collapse hole not but there is no card died, drill the hole directional drilling tools is put forward, to determine the hole collapse period of rough location, back down to the directional drilling tools, in turn when drilling down to hole card section, among every 1 ~ 2 drill pipe spiral stuck with drilling tool added until pass broken hole section, the number of connections can be concrete determined according to the actual situation. After connecting with the directional drilling tool, it goes down into the hole, opens the mud pump punch hole, USES the cutting alloy of the outer pipe wall to agitate and break the large particles at the bottom of the hole. Under the dual action of hydraulic power and screw groove mechanical slag discharge, the deposited coal dust pushes the coal out to the outside of the hole continuously.

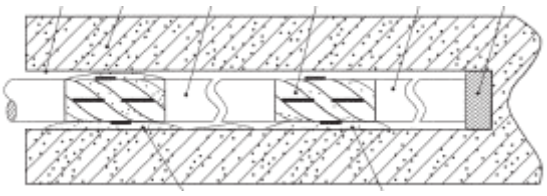

Fig 2. Schematic diagram of working principle of screw release tool

The tool has the following features: Simple structure, easy to use, good signal transmission performance, and the matching drill pipe with the measurement, to ensure the measurement signal transmission in real time reliable; The overall strength and torsion resistance of the alien tube are high, and the reliability of the card is high.Six sets of cutting alloy teeth are set externally to realize the crushing of large pieces of drilling slag. At the same time, it has the function of maintaining normal diameter and avoiding drilling shrinkage[3]. The large groove width, groove depth and arc Angle transition structure are adopted to greatly improve the slag discharge efficiency.

2.3 Structural Design of External Pipe Joint

In order to form a complete set of center line pipe construction, the device outside tube design for 70 mm, consider processing spiral groove, the pipe wall thickness is 12 mm, outside the pipe thread and tool joint, joint structure of "double top", namely the increase in male and female joint thread small end one shoulder, make the male and female connector to connect two shoulder tighten after the deputy, form a "double top" structure, buttress thread thread adopts special structure, cooperate with tool joint. Coal mine drilling tool generally adopt high strength using yield strength greater than 650 MPa and the tensile strength is greater than 800 MPa low carbon chromium manganese molybdenum alloy structural steel, in order to guarantee the strength of the outer tube, while drilling tool spiral stuck outside work has a better comprehensive performance of 42 cr Mo, after the overall conditioning yield strength 810 MPa, the tensile strength of 945 MPa, and joint thread with special heat treatment to improve the fatigue resistance of joint.

2.4 Determination of Spiral Groove Parameters

In order to ensure the auxiliary slag discharge capacity of the screw disengaging tool along the drilling, and to ensure the smooth drilling passage, the design of reasonable screw groove parameters is the key[4]. The parameters of the helical groove mainly include Z of the number of helical groove heads, l of the guide path, a of the depth of the groove, b of the width of the groove, and a of the screw elevation Angle.

(1) The number of screw heads Z and guide path l.

According to the mechanism of screw groove powder discharge, the principle of screw groove slag discharge is the same as that of screw conveyor.

Under the same working condition, the discharge effect of multiple auger is better than that of single head auger. However, the number of heads is so large that the width of the spiral groove decreases, which affects the overall strength[5]. Therefore, it is not a good idea to have more heads of spiral blades. Through test comparison and actual situation in the field, there are more slag deposits at the bottom of the hole in the broken hole section, the number of screw channel heads is 3, and the guide path design is 250 mm, which is conducive to improving the slag discharge efficiency.

(2) Spiral groove width a and groove depth b.

When the drilling screw unclamping tool is used to break large particles of drilling cuttings, the outside surface of the drill pipe is smooth, which cannot give upward force to the precipitated drilling slag, cannot stir up the precipitated coal in the hole, and cannot discharge the slag. In the process of drilling, the drilling slag cut by the drill bit and the drilling slag repeatedly broken are deposited at the bottom of the hole. The screw groove on the outside pipe wall of the device can scrape and break the hole wall, and at the same time, the drilling slag at the bottom of the sedimentary hole can be stirred and suspended[6]. With the increase of the depth and width of the spiral groove, the friction area between the spiral surface and the coal powder increases, the filling rate of the drill pipe increases, and the discharge effect of the screw is improved. Considering the external pipe strength and processing technology, the designed groove depth a is 4.5 mm, groove width b is 22 mm.

(3) Screw elevation Angle.

The rising Angle of the spiral groove directly affects the discharge effect of the screw and is the most important structural parameter of the screw design. Through the analysis of the movement of coal particles, to make wide blade spiral drill pipe has the auxiliary function of powder, drill slag particles of the normal direction of the axis of the thrust force component must be greater than the direction of the axis of resistance, helix Angle alpha exceeds blade with the friction Angle of pulverized coal, pulverized coal can not "sticky" in the spiral groove, along the spiral groove to slide, outside the hole by the calculation of helix Angle alpha for 21 °, lead to 250 mm.

3. Field Test

In the drilling operation, the drilling slag discharge at the hole mouth is reduced. According to the analysis of the real drilling trajectory data, the specific location of the broken zone layer is predicted to be 264-270 m. Analysis the cause of sticking: mainly was for the hole diameter of 96 mm Φ Φ drill diameter 70 mm, 13 mm, annular clearance after the collapse hole drilling slag particle size is larger, can't smooth discharge hole, especially in the use of large amount of pump for punching, drilling and slag under the effect of hydraulic accumulation is close-grained, form "piston", causes huge drilling slag can't rush out, exacerbate sticking; Then lift drill down to the prospective 70 mm while drilling tool to YuCeKa spiral stuck drill position, adjust the mud pump, amount to 170 ~ 200 L/min, adjusting the rotational speed to slow rotation, through the expansion of the spiral unfreezing device of the lateral alloy cutting slag crushing large drill, and assisting the slag discharge spiral groove, through repeated processing, orifice return water become larger and return slag particle size small, hole discharge smoothly. The test results show that the device can play the role of repeated crushing and assisting in removing the slag CARDS, and can effectively establish the smooth drilling water circulation and reduce the risk of sediment sticking.

4. Conclusion

(1) According to the actual needs of the site, a screw disconnecting tool with drilling is developed. The tool is simple in structure and easy to use. The tool can be used to repeatedly crush large particles of drilling chips at the bottom of the hole by means of external pipe cutting alloy.

(2) Field test shows that: with reasonable design of screw unclamping tool, it can effectively play the role of unclamping tool under the condition that the drilling tool is not stuck to death, ensure the drilling tool in the hole to pass the crushing section smoothly, reduce the drilling risk, improve the drilling construction efficiency and shorten the construction period.

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