Development and application of ZDY4300LF narrow split drilling rig

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Abstract: The inconvenient drilling rig relocation, stabilization and azimuth adjustment lead to many problems in the construction of gas drainage drilling in narrow roadway, such as long auxiliary time, labor intensity of workers, low comprehensive drilling efficiency. Through the innovative layout, the power unit and the drilling unit are respectively arranged on two crawlers, and the ZDY4300LF narrow-body split crawler drilling rig is developed. The drilling rig adopts a modular design idea, arranged the pump station and console on the pump truck. The feed revolving device and the stabilizing device are arranged on the drill carriage. The drilling rig and the pumping station are connected by high-pressure hoses. When drilling for gas drainage, the location of the drilling rig and pump truck can be arranged according to the terrain conditions to obtain the best orientation for the drilling construction. The industrial test of the drilling rig shows that the ZDY4300LF narrow-body split crawler drilling rig has the characteristics of compact structure, convenient operation, and convenient moving and relocation, which can solve the problem of gas drainage in narrow tunnels in underground coal mines. Industrial test of drilling rig shows that ZDY4300LF narrow split crawler drill has the characteristics of compact structure, convenient operation, convenient moving and moving, etc.

1. Introduction
Underground gas drainage is the key measure of gas control[1-4]. At present, gas drainage, drainage or pressure relief by drilling in coal and gas outburst seam is the main method to eliminate the danger of coal and gas outburst under the condition of unprotected mining[5-8]. At present, there are two types of drilling rigs used in coal seam gas extraction: one is the split type full hydraulic tunnel drilling rig, which mainly relies on manual handling or short distance moving of the walking mechanism, the moving speed of drilling rigs is slow, the Labor intensity of workers is high, and the auxiliary time for drilling holes is long, but because the drilling rig is made up of pump station, console and main engine, each part of the rig is connected by hydraulic hose, which is small in size and can be flexibly arranged according to the drilling conditions. The other is the crawler type full hydraulic tunnel drilling rig, which can meet the requirements of rapid underground relocation in coal mines and has the advantages of short auxiliary drilling time and high drilling efficiency, but the integral crawler drilling rig is rather large in size and is mainly used in large and medium mines[9], at present, in view of the technical difficulties in the transportation and construction of the existing track drilling rig in the old mining area such as Yima in Henan Province due to the narrow roadway, the advantages of the split drilling rig structure are analyzed, and the ZDY4300LF narrow split drilling rig is developed, the drilling rig is a two-body arrangement of drilling truck and pump truck. The drilling rig can be arranged according to the site construction conditions, effectively solving the technical problems of gas drainage in narrow laneways.
2. Overall scheme design
The gas drainage holes are usually arranged in the side of the inlet and return air roadway of the working face to be mined, and the conveying belt and single hydraulic prop are often arranged in the roadway, leaving limited space for the drilling rig to transport and construct. According to the construction requirements, the width of the drilling rig is controlled at 0.85 m, the maximum output Torque is 4300 Nm, and the maximum rotating speed is 200 r/min. The hole angle can be adjusted from -90° to 90°. The main engine and the angle adjusting device are arranged on the rotary reducer, and the 360° Azimuth adjustment can be realized. A drilling unit and a stabilizing unit are arranged on the drilling rig, a power unit and a control unit are arranged on the pump rig. The power unit provides power for walking and drilling, and the control unit realizes remote control. The overall scenario is shown in figure 1:

![Figure 1 ZDY4300LF(A) drilling rig](image)

3. Design of key components

3.1. design ideas
In order to pass through the narrow laneway with conveying belt, the width of drilling truck and pump truck is designed to be 850mm, and the overall trafficability is improved. The minimum opening height of drilling rig is designed to be 1250mm, in order to improve the stability of the drilling rig during drilling operation, four lower stabilizers can be extended laterally and then firmly supported.

![Figure 2 schematic diagram of drilling rig structure](image)

3.2. Turret mainframe design
The main engine comprises a gyrator, a feed device, a gripper, a rack and a front and rear fastening device. The azimuth angle of the main engine can be adjusted within 360° by means of the Rotary reducer.
which is installed at the bottom of the main engine. Through the Rotary reducer installed on the inner side of the right column of the frame, the pitch angle of the main engine can be adjusted in the range of 0 ~ ±90°. The height of the horizontal opening of the main engine can be adjusted from 1250mm to 2250mm by the matching of the lifting cylinders installed on the left and right sides of the column. The upper stable oil cylinder is installed on the top of the left and right columns of the frame, which can realize the upper stable of the main rig during the construction and improve the safety of the rig during the drilling.

1. Gyrator 2. Feed Mechanism 3. Gripper 4. Rack 5. Front stabilizers 6. After the stable device

Figure 3 the main engine structure sketch map

3.3. hydraulic system design

Three-pump open circulation system is adopted in the hydraulic system of drilling rig, and oil is supplied by rotation and feed separately, which improves the stability of output torque and feed force during drilling. The necessary safety protection loop is set in the system. For example, the anti-jamming protection loop that prevents the drill pipe from slipping and injuring people is designed for the construction of large inclined through-layer drilling, and the anti-jamming protection loop that prevents the feed cylinder from automatically pulling back when the drill pipe is stuck in the construction of the soft and outburst coal seam, improve the security of the system[10-13].

4. Industrial experiments

ZDY4300LF type drilling rig has been used in 11100 working face return air tunnel of Yian Coal Mine. The coal seam has a simple structure, a quick change of coal thickness, a semi-bright coal type, a coal firmness coefficient F value between 0.14 and 0.46, and a coal seam gas content between 10.2 and 12.88 m³/t, an average of 11.54 m³/t, supporting the use of 95 mm wide fin short spiral drill pipe and 103 mm PDC composite bit, construction drilling 8 holes,

| Bore number | Borehole inclination (°) | Depth of bore /m | Design depth /m |
|-------------|--------------------------|------------------|-----------------|
| 1           | 0.5                      | 83.5             |                 |
| 2           | 0                        | 82.5             |                 |
| 3           | 1.5                      | 81               |                 |
| 4           | 1.5                      | 103.5            |                 |
| 5           | 0.5                      | 100              |                 |
| 6           | 0                        | 100.5            |                 |
| 7           | −2                       | 103.5            |                 |
| 8           | −4                       | 103.5            |                 |

All the 8 boreholes constructed in site exceeded the designed hole depth, and the maximum hole depth was 103.5 m. Tested the capability of the drilling rig.
5. Conclusion

Based on the research on the key technology of narrow body split crawler drill, the ZDY4300LF (a) narrow body split crawler drill is developed and the field industrial test is carried out, and the trafficability and construction capability of the drill are tested, the technical problem of gas drainage in narrow roadway in coal mine is solved effectively. The industrial test shows that: A. The drilling rig is reasonable and compact, which can solve the technical problems in the construction of gas drainage borehole in the narrow tunnel. The drilling rig is easy to move, stable, angle adjustment and other drilling auxiliary time is significantly shortened, effectively reducing the Labor intensity of workers; The drilling rig has the advantages of large output torque, reliable performance and so on. It can meet the requirements of medium and deep hole construction.

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