Application of Hydraulic Control Make-up and Rreak-up Device in Improvement Design of Drilling rig

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Abstract: Tunnel drilling rig is widely used in coal mine gas drainage, hidden disaster detection and other construction. In view of the serious problem of thread wear when loading and unloading drill pipe thread of underground drilling rig in coal mine, a pure hydraulic control device is developed. By adjusting the corresponding angle parameters of the hydraulic control device, two actions of rotary feeding can be realized, and the thread can be loaded and unloaded automatically according to the thread pitch. The design of the device is completed, and the structure is applied to the improved design of ZDY750L and ZDY2-300LM drilling rigs. The matching control of feed and rotation of the two drilling rigs when loading and unloading the drill pipe is realized, which can reduce the wear of the drill pipe thread when the full hydraulic drilling rig is loading and unloading, and provides a new idea and solution for the implementation of the full hydraulic drilling rig automatic loading and unloading.

1. Introduction
Tunnel drilling rig is widely used in coal mine gas drainage, hidden disaster detection and other construction. There are two ways to connect the drill pipe, one is to add the rod at the back of the central through hole, the other is to add the rod in the middle. The latter way mainly uses the chuck to clamp the drill pipe and cooperate with the holder to complete the connection of the drill pipe. The middle rod drilling rig mainly relies on the active drill pipe in front of the power head to load and unload the screw thread to complete the drill pipe connection. It is necessary to make and break the pipe frequently during the construction process. At present, the floating between the power head and the holder is used in the process of making and breaking the pipe. However, due to the problems of machining accuracy or hydraulic control, the pipe buckle is often seriously worn. With the progress of technology, we began to use displacement sensors, speed encoders and other means to conduct electronic control operation, improve the control accuracy of the drilling rig, and alleviate the problem of thread wear to a certain extent. However, the equipment cost is high, and this technology can not be transplanted to the pure hydraulic drilling rig, which still can not solve the practical problem comprehensively[1].

2. Design of hydraulic control up and down buckle device
In view of the above defects, through painstaking research and design, combined with long-term experience and achievements in related industries, a control device and its hydraulic control method are designed to realize the matching of feeding and rotating speed of drilling rig’s shackles. Through mechanical and hydraulic means, the problem of thread wear in the construction process of common hydraulic tunnel drilling rig is solved. This technology can also be used in the way of connecting drill
pipe with center through hole and rear rod, which can reduce the labor intensity of workers, reduce the wear of drill pipe thread, and improve the construction efficiency.

The matching control device for feed and rotation speed of hydraulic control make-up and break-up for drilling rig consists of control device structure module and hydraulic system module.

2.1. Structure module design

The control device comprises a parallel pressure reducing valve and an adjustable inclined plane control device; The adjustable inclined handle controls two linear parallel pressure reducing valves to output proportional pressure to the pilot control port of the main valve of the hydraulic system through the inclined plane, so that the rotary valve and feed valve in the main valve can output corresponding flow according to the proportion of the inclined plane mechanism, and drive the feed cylinder and rotary motor to complete the make-up and break-up action. By adjusting the adjustable inclined handle, it can adapt to different drilling rigs. The adjustable inclined plane control device comprises an adjustable inclined plane, a pin shaft, an upper jacking bolt, a rotating seat, a rotating handle, a fixed seat, a lower jacking bolt and a lower spring. By turning the handle, the adjustable inclined plane can rotate around the central axis of the rotating seat. The angle of the adjustable inclined plane can be adjusted through the upper and lower jacking bolts and the lower spring, so as to realize the output proportion of the pressure reducing valve and match the rotation and feeding speed. The parallel pressure reducing valve consists of two adjustable pressure reducing valves, which can reduce pressure in corresponding proportion under the action of adjustable inclined plane. The output pressure of the two pressure reducing valves is adjusted in a certain proportion to control the output flow of the main valve working joint, so as to match the rotation and feed speed. Its structure is shown in Figure 1.

![Structure diagram of rotary control device](image.png)

111 adjustable inclined plane, 112 pin shaft, 113 upper jacking bolt, 114 rotating seat, 115 rotating handle, 116 fixed seat, 117 lower jacking bolt, 118 lower spring

Figure 1 Structure diagram of rotary control device

2.2. Module design of hydraulic system

The hydraulic module includes three position six way directional valve, shuttle valve, main valve, pilot handle, hydraulic pipeline, etc. Through the three position six way valve, the pilot control oil flows to the control ports A1 and B1 or A2 and B2 of the main valve to realize the switching of make-up and break-up. The control oil flows to the control ports A1 and B1 or A2 and B2 of the main valve through the output port of the three position six way valve and the output port of the pilot handle selected by the shuttle valve, so as to realize the switching between the normal construction and the make-up and break-up. The hydraulic system module can be directly connected to the hydraulic system of the drilling rig,
which will not cause any impact on the original hydraulic system of the drilling rig, and the construction can be carried out according to the original operation mode; When connecting the drill pipe, the handle of the rotary control device is operated to make up and break down.

![Hydraulic Control Module System Diagram](image)

**Figure 2** hydraulic control module system diagram

### 3. Application principle and method of hydraulic control up and down device

The use principle and method of the hydraulic make-up and break-up device are as follows:

1. According to the method shown in hydraulic schematic diagram 2, connect the whole set of control device into the control circuit of the drilling rig.

2. After the control oil is adjusted by the control device, it enters the left position of the three position six way valve. After being selected by the shuttle valve, it enters the pilot control ends A1 and B1 of the hydraulic control valve feed and rotary joint of the drilling rig respectively, pushes the valve core, and discharges the non pressure oil at A2 and B2 ends to the oil tank through the shuttle valve, and at the same time, it outputs the high pressure oil to the feed and forward rotation oil circuits. The rig makes up according to the flow rate determined by the valve core opening.

3. After the control oil is adjusted by the control device, it enters the right position of the three position six way valve. After being selected by the shuttle valve, it enters the hydraulic control ends A2 and B2 of the hydraulic control valve feed and rotary joint of the drilling rig respectively, pushes the valve core, and discharges the non pressure oil at A1 and B1 ends to the oil tank through the shuttle valve. At the same time, it reverses the high-pressure oil to the oil circuit of pulling and reversing. According to the flow rate determined by the opening of the valve core, the drilling rig can realize the tripping action.

4. The normal operation of the drilling rig can be realized through the corresponding operation of the feed and rotary pilot operation handle.

### 4. Application case of hydraulic control up and down device in drilling rig improvement

#### 4.1. Improvement of ZDY750L drilling rig

ZDY750L drilling rig can meet the operation requirements of underground floor anchoring construction, with accurate drilling positioning, convenient movement and fast construction, which can greatly reduce
the labor intensity of workers, improve the operation environment and improve the operation efficiency. In the process of use, due to the vertical floor drilling construction, in the process of construction, the manual tightening of the drill pipe thread near the end of the gripper first, and then control the power head active drill pipe to make up. In the whole process, the personnel can manually assist, intervene the angle of the drill pipe to facilitate the screw tightening. However, it is difficult to control the rotational speed and feed speed because the common manual hydraulic valve is used instead of the hydraulic pilot handle. After installing the hydraulic control make-up and break-up device, the drilling process is still carried out in the original way, but in the process of make-up and break-up, the handle of the hydraulic control make-up and break-up device can be operated to improve the operability and reduce the wear of the drill pipe thread\textsuperscript{[2]}. 

4.2. Improvement of ZDY2-300LM drilling rig

ZDY2-300LM drilling rig is a high-efficiency drilling rig specially designed for directional presplitting of roof, which solves the current situation that the construction equipment lags behind the requirements of process and construction method. The rotary motion of the drilling rig is controlled by the hydraulic friction positioning pilot handle, and the feed oil cylinder is controlled by the hydraulic spring reset pilot handle, which is just opposite to the floor anchoring drilling rig. The slotting drilling rig carries out the construction to the roadway roof. After the manual tightening of the drill pipe close to the screw thread at the power head end, the rotary motion is carried out at a low speed, Operate the feed handle to tighten the screw thread at the end of the drill pipe near the gripper. However, due to the high level of the gripper at this time, there is no legal person to interfere with the drill pipe alignment, so the active drill pipe is worn seriously and replaced frequently in the process of make-up and break-up. In the process of improving the design of the drilling rig, the active drill pipe thread is strengthened locally to improve the material performance and heat treatment process, but the effect is general. By installing the hydraulic control make-up and break-up device, the make-up and break-up operation is optimized and the service life of the active drill pipe is extended\textsuperscript{[3-4]}. 

Figure 3 Schematic diagram of ZDY750L drill rig

Figure 4 Schematic diagram of ZDY2-300LM drill rig
5. Conclusions

The matching control device for feeding and rotating speed of drilling rig's make-up and break-up has the following effects:

1) Simple structure, convenient operation and maintenance.
2) Through the matching control of feed and rotation speed, the wear of drill pipe thread and slip on and off the rig is greatly improved.
3) It is suitable for the hydraulic system of most drilling rigs and can be modified without damage.
4) It is better to solve the buckle problem by floating the oil cylinder, which is not affected by the external load.

References

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