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## Working Performance Analysis and Optimization Design of Rotary Drilling Rig under on Hard Formation Conditions

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### Abstract

The rotary drilling rig rapidly popularized in the construction project because of its efficiency, quickness, environmental protection, good hole-forming quality and other advantages. But in drilling hard rock, there are some problems, such as low service life of key position, low construction efficiency and others,. In this paper, these existing problems for power head, drill pipe etc. of working device of rotary drilling rig were analysed. The rotary drilling rig power head removable combined drive key design and rotating seal transition device design which is adapted to drill hard formation put forward the innovation. The rotary drilling rig power head and drill pipe were optimized design and improved. The productive test of rock pile hole drilling which drilling depth is 80m and hole diameter is 2m at fourth tender section on Qingzhi highway, GuiZhou province, shows that the working device optimized and improved well meet the requirements of the pile hole drilling construction under hard formation conditions.

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*Key words:* Rotary Drilling Rig; Hard Formation; Power Head.

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### 1. Introduction

The rotary drilling rig rapidly popularized in the construction project because of its efficiency, quickness, environmental protection ,good hole-forming quality and other advantages. A large number of rotary drilling rigs

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had entered into the Yunnan, Guizhou, Sichuan and other southwest regional markets since 2011. The rotary drilling rig often encountered in lava strata in these regions, and the mechanical accidents often happened in construction. Especially the main working device (power head, drill pipe, drill bucket etc.) of rotary drilling rig cannot adapt to the operating requirements of hard formation condition, which are mainly reflected in the weak strength of key parts, low service life and so on. Therefore, the rotary drilling rig optimization design which is suitable for drilling in hard formation conditions is an important research subject with practical significance<sup>[1-2]</sup>.

## **2. Analysis on Common Faults and Its Reason of Rotary Drilling Rig under Hard Formation Conditions**

In order to realize to high drill rock efficiently, the rotary drilling rig must possess large torque pressurized force of effective transmission and high hardness and abrasive resistance of drill tool cutting teeth. However, as a result of the limitation of two back factors, the construction efficiency of rotary drilling rig is extremely low under hard formation conditions. In addition, stratum faced with counter-acting force of equipment have high fluctuation and peak, which makes equipment and working devices and other structural parts have high fatigue damage, machinery failure rate and rig maintenance costs. It is embodied in the following respects:

### *2.1. Drive Key Wear*

The torque of rotary drilling rig power head transmit to drill pipe mainly through power head drive key, and transmit to drill tool through drill pipe for drilling. When rotary drilling rig works, the rotary drilling rig power head depends on two sides and bottom pressurized surface of the drive key vertical direction to drive drill pipe rotation of positive and negative directions and transmit pressurized force. The long-term drive, knob and pressurization result to the drive key of rotary drilling rig power head and the pressurized key wear faster and the failure of pressurization and drive function, which affects usability of rotary drilling rig. Therefore, the drive keys wear is a common problem of rotary drilling rig.

At present, in order to realize drive and pressurization of drill pipe, the drive keys of rotary drilling rig power head designed by the rotary drilling rig manufacturers at home and abroad are all adopted three drive keys; there are the welded and detachable in structure<sup>[3-4]</sup>.

### *2.2. Oil Leak of Power Head Box*

The oil leak of power head box on-stream is the easiest way to the problems of rotary drilling rig power head, which is embodied in that the gear lubrication of box seep from one or a few points between the rotation axis and rotating sealing lip. The reasons for the oil leak are based on the following three points.

- 1) Rotating seal is installed correctly or not.
- 2) Machining accuracy could't meet the installation requirements of rotating seal.
- 3) Scrap iron produced by the running-in of the slewing bearing and the pinion of the box destroy seal lip, which leads to seal failure.

At present, the bottom of power head box is generally designed one or two rotating seals for sealing the gear oil of box. In order to insure that lubricating oil slick seal can be formed effectively, corrosion, scratches, and air holes appeared in the surface of rotating seal assembly must be avoided. In practical construction, the rotation axis receives the radial direction impact, and the outside impurities such as mud, sand and water are easy to enter the box, which leads to rotation axis contacted with seal lip milled groove and oil seal failure. The higher value rotation axis can only be replaced for solving the malfunction. Because of the high cost, it is difficult for user to accept it.

### *2.3. Shock Absorber Damage*

When the drilling depth of rotary drilling rig is longer than the first quarter length of drill pipe, drill pipe flange plate will fall on the shock absorber of power head, and at the moment, the weight of drill pipe almost all fall on shock absorber of power head. The drilling rig drilling down or lifting will pose the power head a impact, so as to damage the structure of power head. More seriously, when drill pipe is locked or brought up, the drill pipe brought

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