



FAILURE ANALYSIS OF BEARING STRUCTURE OF ROLLER BIT

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ABSTRACT

At present, the performance of high-speed cone bit bearing metal seal structure cannot meet the drilling requirements. It results in low drilling bits of life, so that the drill bits quickly failed, drilling efficiency is reduced, and increased drilling costs. The author analyzes the failure of rubber ring and metal ring, and the failure analysis of rubber ring is mainly for the aging of rubber, abrasive wear, the influence of mechanical movement of roller cone and the influence of high temperature and high pressure.

Key Words: Cone bit, Bearing seal, Rubber ring, Metal ring

0 Introduction

The bearing seal structure is one of the key components of the cone bit and the major wearing parts. Its sealing performance directly affects the working performance and service life of the cone bit. Through field use found: severe wear and tear due to the early failure of the seal accounted for 30% of the failure of the bearing, greatly reducing the drilling efficiency and increased drilling costs^[1-2]. Therefore, it is of great significance to carry out the research on the bearing seal structure of the cone bit bearing to improve the service life of the cone bit.

1 Failure Analysis of Rubber Ring

1.1 Characteristics of Rubber

Compared with the metal, the characteristics of rubber can be summarized as follows^[3]:

(1) The elastic modulus is small and deformation is large. The rubber can exhibit a high degree of deformation under a small external force. When the removal of external forces, it can also to restore the original form, permanent deformation is very small.

(2) The deformation of the rubber takes some time. When the rubber is compressed or stretched by external force, if the deformation increases with time, and finally reached the maximum deformation, this phenomenon is called creep. Or, the tension of the rubber gradually

loose, the phenomenon of this stress increases with time or decline or disappearance known as stress relaxation.

(3) Deformation has a thermal effect. Rubber will heat up when it stretches, absorbs heat when retracted, and when it stretches it will increase its thermal effect with elongation. Sealing design and use need to pay attention to this problem, when the cone bit in the high-speed rotation, the rubber internal friction heat plus the external friction heat will cause the rubber to reduce the wear resistance.

1.2 Aging of rubber

The phenomenon of the rubber ring of the cone bit in the course of the use, due to the heat, mechanical energy and in the bottom of the chemical reaction, physical and mechanical properties, elongation and other significant decline, resulting in the loss of the use of rubber ring value, we call it the aging of rubber. After the aging, rubber ring of the material will become brittle, fall of and slit by the phenomenon of wear. The aging of the main reasons for the following^[4]:

(1) It will have a lot of shear deformation because rubber ring compression rate is large and the ability of the rubber ring shear deformation is much less than anti-compression deformation. So the excessive compression rate will intensify the aging of the rubber ring, resulting in plastic deformation, reduce the elasticity of the rubber ring, thereby reducing its life.

(2) The molecular structure of the rubber material has changed under the action of the low frequency vibration and the change in the pulse pressure caused by the wave bottom. The cause of this phenomenon is the force and heat, rubber deformation in a number of hysteresis after the phenomenon, making the rubber inside the heat.

(3) The rubber material becomes brittle and abrasion resistance greatly reduced because of the bottom of the temperature is too high.

(4) High temperature resistance and poor corrosion resistance of rubber material.

1.3 Abrasive wear of rubber

We must ensure that the mud and impurities do not enter the bearing cavity and need to move the seal inside the grease to maintain the pressure slightly larger than the pressure of the outer mud, so a small amount of grease leak when drilling is working. The number of greases is reduced but can not be replaced at work, so the accumulation of impurities in the grease, causing the rubber ring abrasive wear and tear. Abrasive wear is a complex process of mechanical action, chemical action, thermochemical interaction, etc. At present, domestic and foreign research is only on the basis of the experiment on a variety of simple process on the line research.

1.4 The Influence of Mechanical Movement of

Due to the low frequency vibration and the change of the pulse pressure caused by the corrugated bottom hole, the cone has a great influence on the life of the rubber seal. Low-frequency vibration will allow the mud in the mud, rock debris gathered in the seal around, as in the rubber seal around the sharp knife cutting the seal ring and resulting in its soon failure. While the pulse change of the drilling pressure exacerbated the fatigue damage of the seal.

1.5 Effect of High Temperature and High Pressure on Rubber Seal

The rubber ring due to temperature rise and softening, elastic modulus and tensile strength will decline with the drilling depth of the continuous increase in the bottom of the temperature is gradually increased and results in the seal wear accelerated. And it will accelerate the aging of rubber by the seal ring for a long time by the impact of high temperature.

Rubber seals with the depth of the increase at the same time the pressure will increase, by the high pressure extrusion ring part of the rubber was squeezed into the seal and fall off, so that the loss of sealing. When the seal in a high-pressure environment, the supercritical gas CO₂ and H₂S can make rubber expansion, thereby increasing the extrusion, so that the seal quickly failed.

2 Failure Analysis of Metal Ring

The dynamic ring and the static ring that make up the dynamic seal structure are the key parts of the metal seal structure. In the manufacturing process of the metal ring, the roughness of the dynamic sealing surface requires a strict processing requirement so that it can form a layer of a lubricating liquid film having a thickness of about 0.5 to 2.0 μm at work^[6]. With the increase of drilling depth and impurity, the friction heat of the contact surface is increased, and the wear of the sealing surface is exacerbated, so that the dynamic sealing surface can not lose the stability of the lubricating liquid film. The reason can be summarized as follows:

(1) Sealed structural design is unreasonable, resulting in moving the pressure distribution of the sealing surface is not uniform, making the grease leakage increased and the outside of the impurities easily into the sealing surface, resulting in sealing surface wear.

(2) Metal seal must ensure that the accuracy of the installation of each component that is good neutral, if the poor neutral, will lead to sealing is not tight. So that the reliability and stability of the seal will reduce.

3 Summary

The main reason of the failure of the seal of cone bit can be summarized as follows: Rubber aging, abrasive wear, temperature and pressure increase, the low frequency vibration of the cone and the change of the pulse pressure, the influence of the bearing quality of the cone and the bearing seal structure, the influence of the bearing support wear, the oil pressure compensation system performance. The effects of drilling fluid on the chemical corrosion of the seal. The main

reason is the rubber ring wear, aging and metal ring wear. Factors that have a large impact include the structure of the bearing seal, the choice of materials, the manufacturing and processing processes, and the formation of the dynamic seal surface lubricant film.

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