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# STUDY ON SINGLE METAL FLOATING SEAL FOR CONE BIT BEARING

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**ABSTRACT**

With the development of drilling technology, the number of drilling deep wells, ultra-deep wells are also increasing. From the depth of drilling in the strata, the cone bit has an irreplaceable advantage. Studies have shown that one of the major factors affecting the life of a cone bit is the seal life of the bearing system. In this paper, ABAQUS finite element software is used to analyze the single metal floating seal structure of typical cone bit bearing, and simulate the deformation of the floating end seal assembly process and the change of contact surface stress. This has reference value for the design of similar floating end seal structure.

**Key Words**: cone bit ； single metal ； floating seal ；ABAQUS; finite element

## 0 INTRODUCTION

With the exploitation of oil and gas resources continue to deepen, The oil and gas resources in the shallow of earth continue to decrease. The exploitation of oil and gas began in more severe environments such as deep seas, deep strata, deserts, plateaus and so on. Deep wells, ultra-deep wells, directional wells and large displacement horizontal wells are gradually being widely used. From the depth of drilling in the strata, the cone bit has an irreplaceable advantage. Studies have shown that one of the major factors affecting the life of a cone bit is the seal life of the bearing system. [1] With the increasing difficulty of the drilling, The working environment of the drill bit is getting worse. The drill bit life and reliability also put forward higher requirements. Take the cone bit for example, It will be in the more harsh working environment to withstand greater work load such as greater pressure, torque and lateral force, etc. Its bearing seal is the only barrier to prevent the external drilling mud into the bearing. Once the bearing seal structure fails, Drilling mud will be directly into the bearing. The bearing will be invalid because of bearing stuck or bearing abrasive wear [2]. In this paper, ABAQUS finite element software is used to analyze the single metal floating seal structure of typical cone bit bearing, and simulate the deformation of the floating end seal assembly process and the change of contact surface stress. This has reference value for the design of similar floating end seal structure.

## 1 Establishment of Finite Element Model

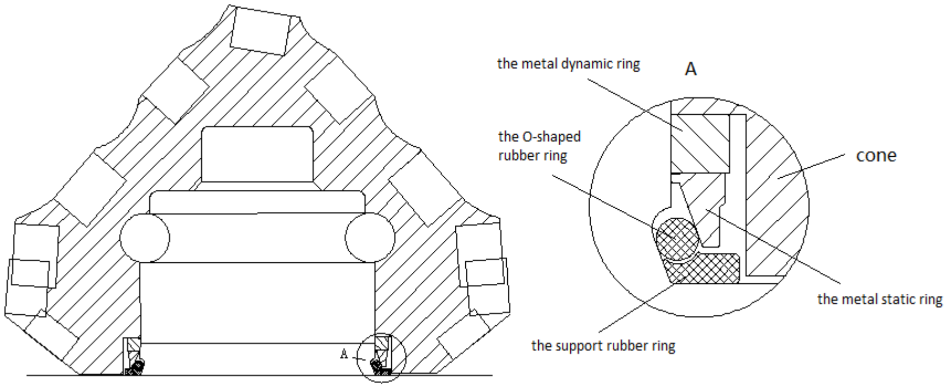


Figure 1 The SEM2 type structure of single metal floating seal for cone bit bearing

### 1.1 The SEM2 type structure of single metal floating seal for cone bit bearing

As shown in Figure 1

### 1.2 Selection of sealing structural materials

Taking into account the axial symmetry of the seal structure, the parts are created using an axisymmetric model. The material of Sealing structure are metal and rubber. The mode of Mooney-Reviling is used to the material of the O-shaped rubber ring and the supporting rubber ring. The rubber material constants C10 and C01 were 1.87 and 0.47 that are determined from the experimental data. The material elastic modulus for dynamic ring and static ring of metal seal is E = 210GPa.Poisson's ratio is $\mu = 0.3$. The claw journal and the axial end of the cone are treated as rigid bodies [3] .

### 1.3 The creation of mutual contact and the division of the grid

There are three forms of contact with each other, metal and metal contact, metal and rubber contact, rubber and rubber contact. The grid is divided by two ways. The metal adopts CAX4RH four-node bilinear axisymmetric quadrilateral element. The rubber adopts CAX4H four-node bilinear axisymmetric quadrilateral element. The loading method uses displacement loading.

## 2 Analysis of Simulation Assembly of Finite Element Model

The Mises stress cloud of the assembled model is shown in Fig 2， The contact stress cloud is shown in Fig 3. As can be seen from the figure, the maximum stress of the dynamic sealing surface is in the outside of the sealing structure. The maximum value of the contact stress is 43.16 MP. It ensures the reliability of the seal that the maximum value of the contact stress appear on the outside.

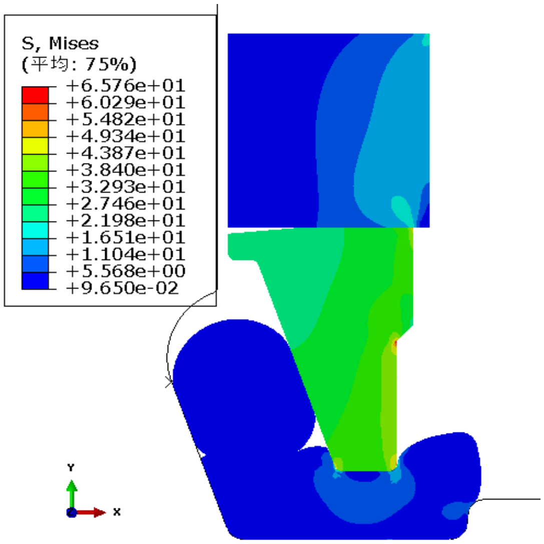


Figure 2 The Mises stress cloud

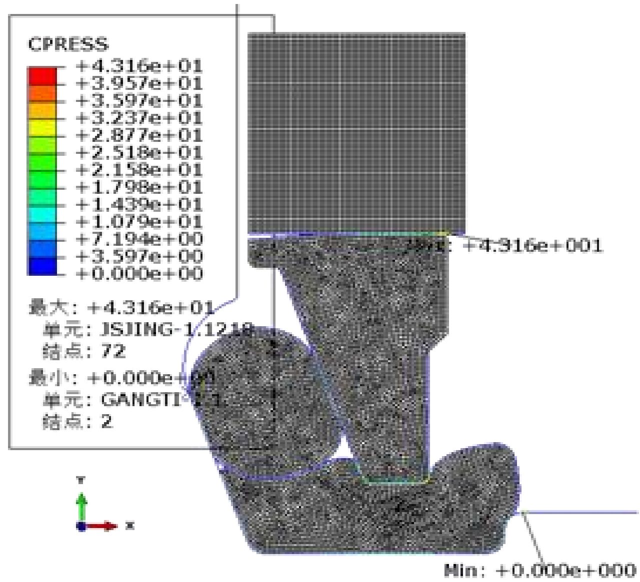


Figure 3 The contact stress cloud

But the stress of the outside cannot be excessive to cause excessive wear, So that the seal premature fail. We can calculate the required sealing force according to the actual working conditions to adjust the assembly displacement, so as to achieve the best sealing effect.

The metal static Mises stress cloud is shown in Fig 4. The metal dynamic ring Mises stress cloud is shown in Fig 5.As can be seen from the figure, The stress distribution of the metal static ring appears the stress concentration on the outside. This is mainly due to excessive design unreasonable lead. While the stress distribution of the metal dynamic ring is relatively uniform, It can achieve a good seal.

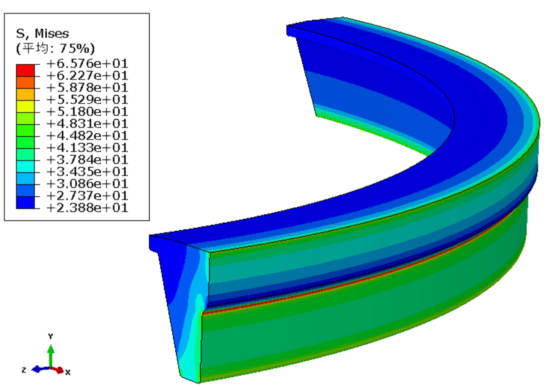


Figure 4 The metal static Mises stress cloud

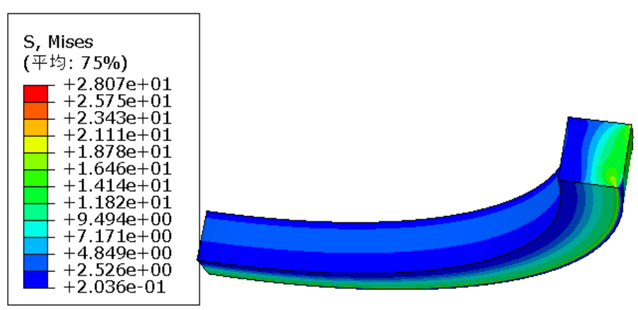


Figure 5 The metal dynamic ring Mises stress cloud

The Mises stress cloud of the O-shaped rubber ring is shown in Fig 6. The Mises stress cloud of the support rubber ring is shown in Fig 7. As can be seen from the figure, the stress of the O-shaped rubber ring concentrate in the back. The stress value is 4.45MP. The stress distribution of the support rubber ring is uniform, the maximum value reached 50.9MP, This indicates that the support rubber ring provides the main sealing force after assembly

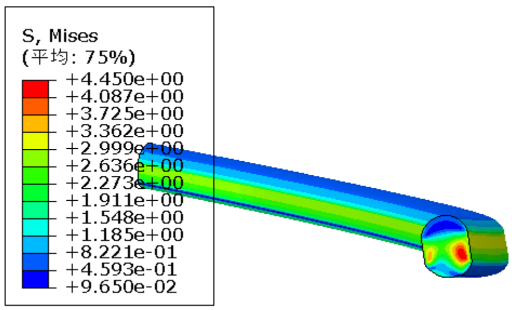


Figure 6 The Mises stress cloud of the O-shaped rubber ring

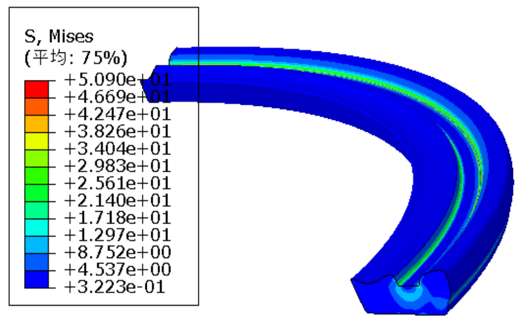


Figure 7 The Mises stress cloud of the support rubber ring

## 3 Conclusion

(1) The stress of the dynamic sealing surface gradually decreases from outside to inside. This makes the seal reliable, but also conducive to the lubrication of the Inner side. But the stress of the outside can not be excessive to cause excessive wear, So that the seal premature fail. We can calculate the required sealing force according to the actual working conditions to adjust the assembly displacement, so as to achieve the best sealing effect.

(2) The stress distribution of the static seal is uniform. A good sealing effect can be achieved. The stress concentration Can be decreased by optimizing the structure of O-shaped rubber ring, this will increase the reliability of the seal.

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