

Simulation Analysis of Friction and Wear of New TiAl based Alloy Joint Bearings

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Abstract. Using Workbench simulation to analyze the friction and wear characteristics of joint bearings under axial load of 1KN and rotation speed of 100r/min. Contrasting simulation results show that the new TiAl-based alloy can effectively improve the joint bearing friction and wear performance, and it occurs on the inner ring of the joint bearing.

Keywords: Simulation analysis; joint bearing; friction and wear.

1. Introduction

The joint bearings are special kind of sliding bearings, which have excellent load bearing, impact resistance, corrosion resistance and so on, they have been widely used in many engineering fields such as heavy machinery, aerospace, vehicle engineering [1].

In actual work, friction and wear are the main failure modes of joint bearings. Therefore, improving the friction and wear characteristics is great significance to joint bearings.

TiAl-based alloys have high specific strength, low density, good corrosion resistance and good mechanical properties such as high temperature creep resistance under high temperature conditions [2, 5]. TiAl alloys are considered to be the most promising new generation of alloy materials [6]. This makes it possible for TiAl-based alloys to be ideal joint bearing materials under high heavy load conditions. Here, using workbench to simulate a new type of TiAl-based alloy material with strong bearing capacity and good friction and wear characteristics under certain conditions, and compared with the joint bearing of common material.

2. Joint Bearing Simulation Analysis

2.1 Joint Bearing Simulation Setting

Joint bearing three-dimensional model is established by Solidworks shows in Fig.1. Table 1 shows the inner and outer ring materials of different joint bearings. Set the simulation parameters according to the material properties as shown in Table 2.

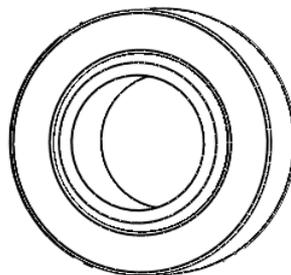


Fig. 1 Schematic diagram of joint bearing structure

Table 1. Joint bearings of different materials

Numble	Inner ring	Outer ring
1	GCr15	GCr15
2	New TiAl based alloy	GCr15
3	New TiAl based alloy	New TiAl based alloy

Table 2. Joint bearing material parameters

Material	E(GPa)	μ	Density (g/mm ³)
GCr15	207	0.3	7.8
New TiAl based alloy	85	0.29	4.1

According to the actual working conditions, the joint bearing simulation conditions are determined: 1KN load is applied in the axial direction, and the inner ring rotation speed is set to 100r/min. Fig. 2 shows the application of the bearing and the restraint of the joint bearing.

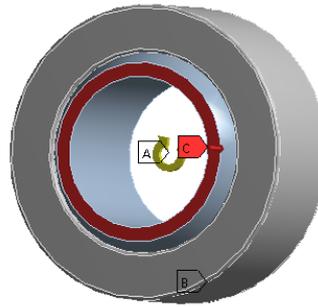


Fig. 2 Joint bearing load and constraints

2.2 Joint Bearing Simulation Analysis Results

Under the above conditions, the simulation results the three kinds of joint bearings frictional stress are as follows.

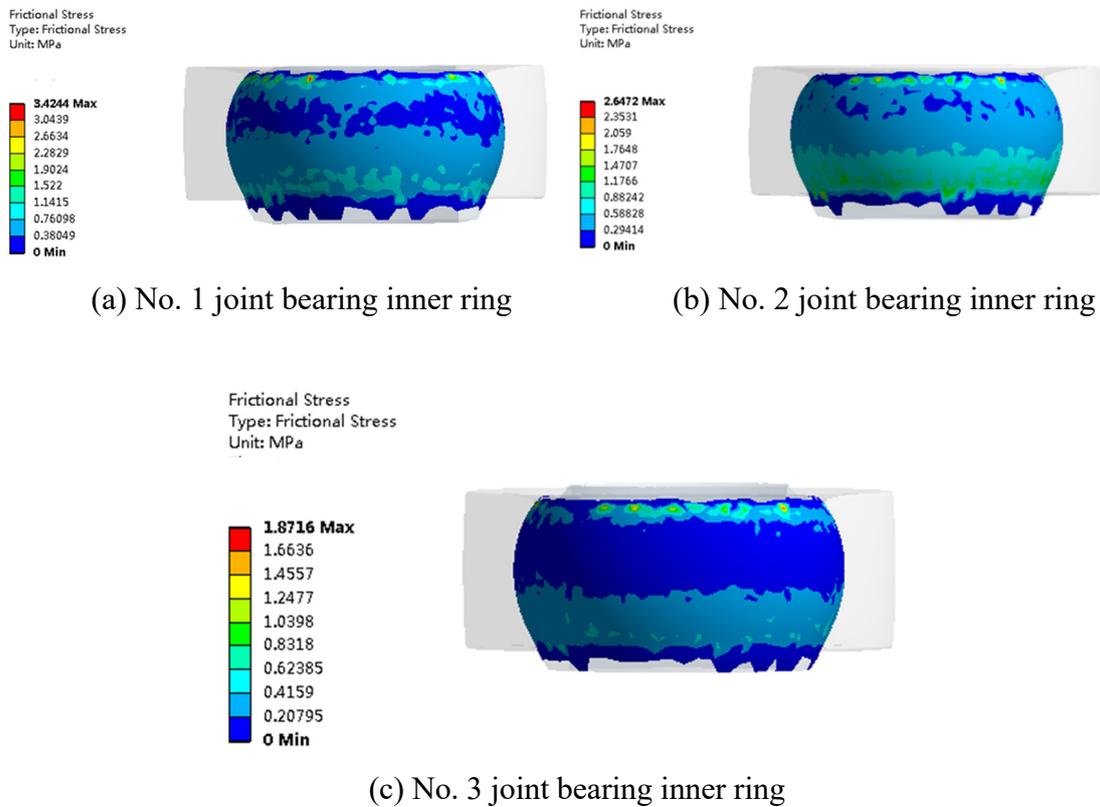


Fig.3 Friction stress cloud diagrams of inner ring of joint bearings

Fig.3 (a) (b) (c) is the frictional stress cloud diagram of the inner ring about the 1, 2, and 3 joint bearings. From the analysis of the friction stress values, it can be known that the No. 1 joint bearing inner ring frictional stress is the largest, No. 2 is the second, and No. 3 is the least. The maximum

friction stress value, No. 1 is 3.42 MPa, No. 2 is 2.63MPa, No. 3 is 1.87MPa. According to the frictional stress cloud diagrams of the inner ring about the three kinds of joint bearings, there is no stress concentration in the inner ring. But the stress cloud diagram of the No. 3 joint bearing changes more evenly, indicating that the force is relatively uniform.

Fig. 4 shows the simulation results of the frictional stresses about the outer rings of three kinds of joint bearings.

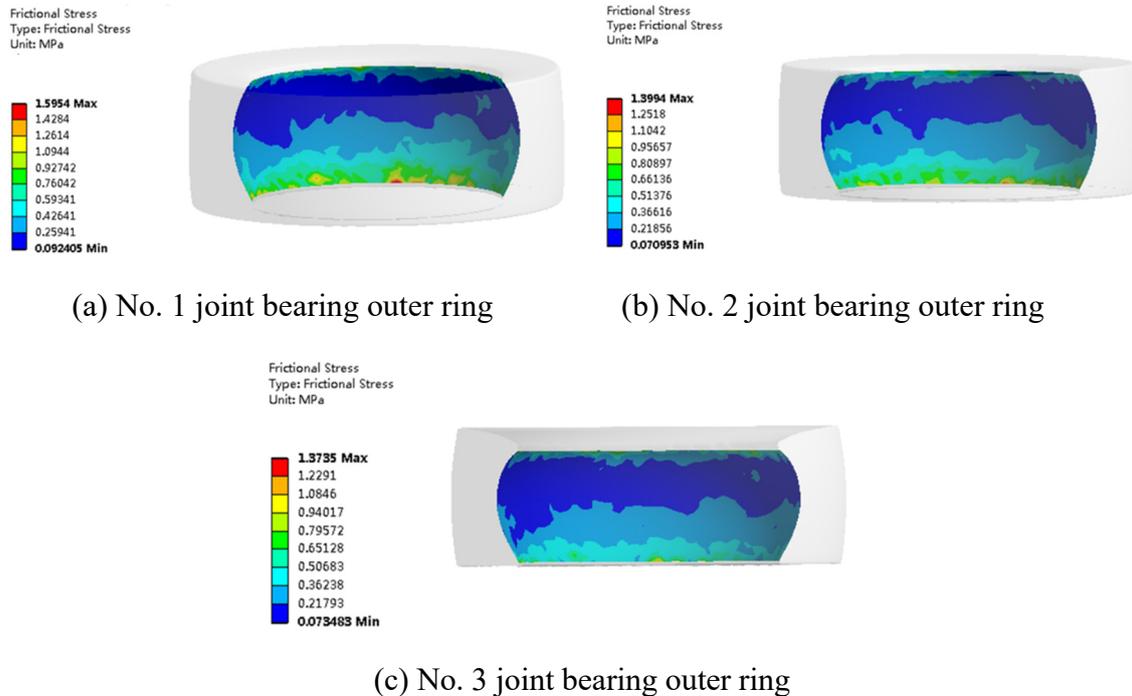


Fig. 4 Friction stress cloud diagrams of the outer ring of the joint bearings

It can be seen from Fig. 4(a)(b)(c) that the maximum stress value of the outer ring of the No. 1 joint bearing is 1.59 MPa, and the maximum stress value of the inner ring of the No. 2 joint bearing is 1.399 MPa, and the maximum stress value of the No. 3 joint bearing is 1.37 MPa. Compared with the trend of the inner rings, it is found that the outer rings maximum friction stress value is smaller than the friction stress value of the inner rings, indicating that the inner rings friction wear is more severe under the working condition. The main reason is that the joint bearing will happen frictional heat generation phenomenon in the under the condition of rotation, and the inner ring heat dissipation is not as good as that of the outer ring, so the friction stress value of the joint bearing outer ring is smaller than the stress value of the inner ring. Comparing the frictional stress cloud diagrams of the three kinds of joint bearings outer rings, at the bottom of No. 1 joint bearing appeared significant stress concentration. Similarly, the outer ring of the No. 2 joint bearing showed a certain stress concentration at the same position, but the friction stress concentration was smaller than that of the No. 1 joint bearing outer ring, and the No. 3 joint bearing did not exhibit friction stress concentration.

3. Summary

The simulation analysis the joint bearing frictional stress found that No. 3 joint bearing performed best, the No. 2 joint bearing was the second, and the No. 1 joint bearing was the worst. It shows that the new TiAl-based self-lubricating alloy can effectively improve the friction and wear performance of the joint bearing. At the same time, compared with the simulation results of the No. 2 and No. 3 joint bearings, the frictional stress is not much different, which indicates that the friction and wear of the joint bearing is mainly Occurs on the inner ring of the joint bearing.

Acknowledgments

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