Numerical Analysis of Leakage Rate of Nanoparticles-Laden Oil in Sealed Ball Bearing

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1. Introduction

Temperature rises in a sealed ball bearing after long-time working. With the temperature rising, the lubricating oil leakage rate increases [1]. In order to reduce the amount of leakage, nanoparticles were dispersed into the lubricating oil. A computational fluid dynamics (CFD) method was adopted to simulate the flow field of seal clearance in the bearing. The effects of temperature and nanoparticles content on lubricating oil leakage rate were investigated.

2. Numerical analysis method

Figure 1 shows the sealing model in a sealed ball bearing. The dark region that is surrounded by heavy line is the flow field for numerical analysis. In this region, the upper area is air, and the below area is nanoparticles-laden oil.

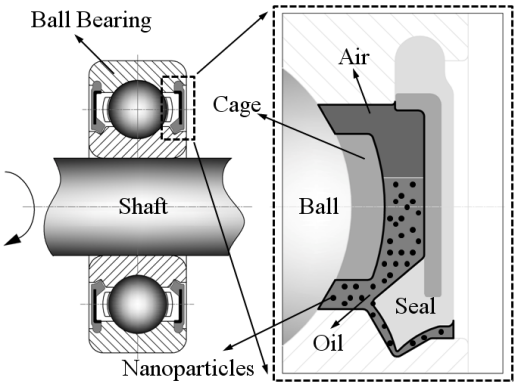
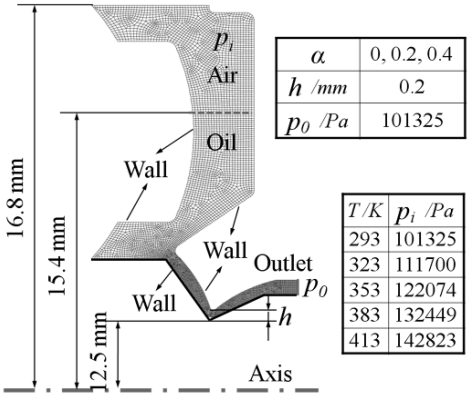


Fig.1 Sealing model for numerical analysis

Figure 2 shows the calculation grids and boundary conditions of the flow field.



α	0, 0.2, 0.4
h /mm	0.2
p_0 /Pa	101325

T/K	p_i /Pa
293	101325
323	111700
353	122074
383	132449
413	142823

Fig.2 Grids and boundary conditions

The minimum seal clearance is 0.2mm. So the seal is in fluid lubrication state. The air expands with the temperature rising in bearing. Then, an inner pressure (p_i) appears. The relationship between temperature and inner pressure is listed in Fig.2. To simplify the model, the deformation of seal rubber and the shape of seal clearance are not considered.

3. Numerical analysis results and discussions

Figure 3 shows nanoparticles effects on leakage rate. With the nanoparticles volume fraction (α) increasing, the leakage rate of lubricating oil decreases under the same temperature. With the temperature increasing, the leakage rate of lubricating oil increases under the same nanoparticles volume fraction.

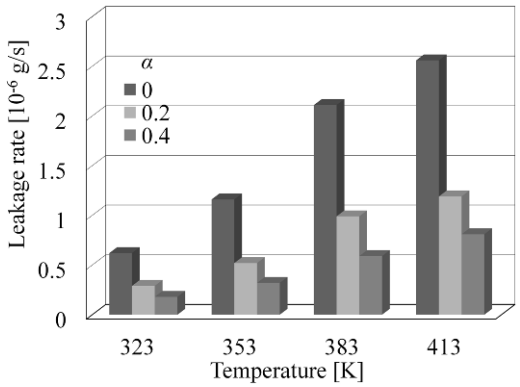


Fig.3 Nanoparticles effects on leakage rate

From the variation of leakage rate in Fig. 3, the inner pressure that caused by temperature rising is the main reason of leakage. Due to simplifying the model and ignoring the scale effect of nanoparticles, the leakage rate changed by nanoparticles may be much smaller than the actual situation.

4. Conclusions

The leakage rate of nanoparticles-laden oil in sealed ball bearing was investigated by CFD method. The leakage of lubricating oil can be decreased obviously by adding nanoparticles into lubricating oil, and the leakage mass flow rate decreases with the nanoparticles volume fraction increasing.

5. References

[1] Kang, Y. S. and Sadeghi, F., "Numerical Analysis of Temperature Distribution at the Lip Seal-Shaft Interface," J. Tribology, 119, 2, 1997, 273-278.

6. Acknowledgement

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