Design of high performance externally pressurized gas bearings

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Design of High Performance Externally Pressurized Gas Bearings

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Summary

A new gap shaped externally pressurized gas (EPG) bearing was developed, which has higher load carrying capacity, higher stiffness than other gap shaped EPG pads. Furthermore, since no-flexible part is used, design procedures can be simplified and the additional instability is eliminated.

Introduction

The EPG bearings (pads) with convergent conical shapes have been noticed for years, as summarized in [1], because this kind of bearings can provide high load capacity and high stiffness. This paper presents the numerical and experimental investigation on a new type of conical gap shaped EPG pad - the multi-conical EPG pad. Under the same conditions, multi-conical shaped pads have high stiffness, high load capacity and a wide stable region.

Multi-conical gap shaped, circular EPG pads

Fig. 1 presents the illustration of the gap shape area of simple conical and multi-conical EPG pads. Our research shows that when the diameter ratio (DC/DD) of a simple conical pad equals unity, both load capacity and stiffness increase with gap difference (h_v). In other diameter ratios, there is an optimum gap difference to achieve high stiffness. Fig. 2 shows the changes of the stiffness and the load capacity of simple conical EPG pads for different diameter ratios. It can be seen that optimized diameter ratio is located about 0.8 to 0.9.

However, the choice of h_v and DC/DD are limited by stability of EPG pads. The stability criteria of simple conical EPG pads is plotted in Fig. 3, which gives important information on the combination of gap differences and the characteristic diameter ratios, for instance, the optimized diameter ratio for the simple conical pad requires a gap difference of about $5\text{ }\mu\text{m}$ to ensure the stability. If we design a pad gap shape according to the relationship of the diameter ratio and the gap difference, a stable EPG pad with high load capacity and high stiffness can be achieved. Tri-conical gap shape is a simple approach for this.

The results of FEM calculations and experiments for a optimized simple conical pad and a tri-conical circular pad are further illustrated in Fig. 4, from which it can be seen that multi-conical pads are indeed optimized pads.

Fig. 1. Illustration of conical and multi-conical EPG pads

Fig. 2. Static characteristics in terms of diameter ratio

Fig. 3. Stability criteria

Fig. 4. Numerical and experimental results of conical EPG pads

Conclusions

The multi-conical shaped pads can be considered as an approach to design the high stiffness, high load capacity and stable EPG bearing pads. Both FEM calculations and experiments shows that multi-conical shaped EPG pads can indeed reach this goal.

References

1. J. M. Wang : Principles and methods to improve the stiffness of aerostatic bearings. 1988, Master Thesis, Eindhoven University of Technology