STUDY ON CAVITATION OCCURRENCE IN HIGH-SPEED HYBRID WATER-LUBRICATED THRUST BEARINGS

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Fluid lubrication; Hydrodynamic Lubrication; Texturation; Cavitation

ABSTRACT

Recently, spindles with high precision, high stiffness, and high speed have been attracting attention, but it is very difficult to achieve both high speed rotation and bearing stiffness with conventional bearings. Therefore, hybrid (hydrostatic and hydrodynamic) water-lubricated bearings are attracting attention[1]. In this study, the characteristics of high-speed water-lubricated hybrid thrust bearings were numerically investigated using commercial Computational Fluid Dynamics (CFD) software and a bearing structure that can suppress cavitation was proposed.

Figure 1 shows the water-lubricated hybrid thrust bearing used in this study. As shown in the figure, the bearing consists of six bearing pads, and fluid pressure increases when fluid flows from the shallow pocket to the land. This makes it act as a hydrodynamic bearing and, by using pressurized fluid, it can also function as a hydrostatic bearing. Figure 2(a) shows an overview of the bearing.

In this study, the flow of water inside the bearing was numerically calculated using CFD software ANSYS CFX 2021 R1. The water flow was assumed to be laminar and a gas-liquid two-phase flow was calculated. Figure 2(b) shows the numerical results of the volume fraction of the liquid phase when the shaft speed is set to 30,000 rpm under the following calculation conditions: water supply pressure *psg* = 0.1 MPa and bearing clearance *ht* = 25 µm. The figure shows that the liquid phase volume fraction decreases in the area of the inflow from the shallow pocket to the land, indicating the occurrence of cavitation.

Cavitation is undesirable in the practical use of water-lubricated bearings because it can cause erosion. Therefore, a bearing with a circumferential groove of the same depth as the shallow pocket was proposed in this study, as shown in Figure 3(a), to suppress the pressure drop at the point where cavitation occurs. Figure 3(b) shows the numerical results of the liquid phase volume fraction of the proposed bearing. The figure shows that the occurrence of cavitation is suppressed.

Figure 4 shows the results of the visualization experiment. As in the numerical results, bubbles were observed in the inflow area from the shallow pocket to the land. Future experiments with the proposed bearing will be conducted to verify the effectiveness of the proposed bearing in suppressing cavitation.

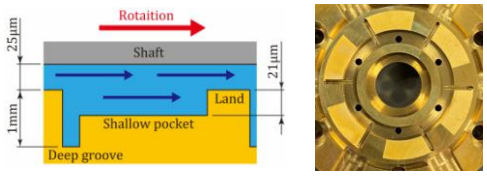
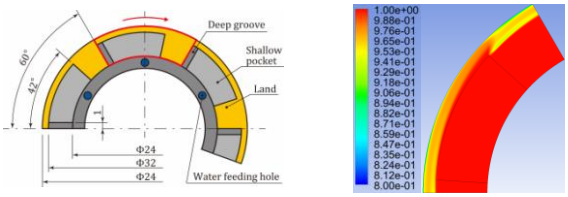
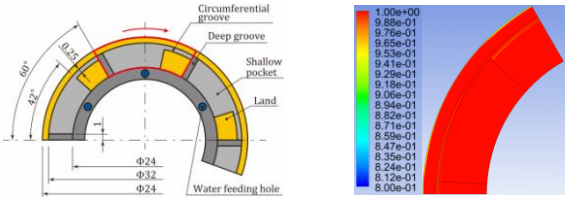


Fig.1 Hybrid water lubricated thrust bearing



(a) Bearing model (b) Liquid volume fraction
Fig.2 Numerical results (Conventional bearing)



(a) Bearing model (b) Liquid volume fraction
Fig.3 Numerical results (Proposed bearing)

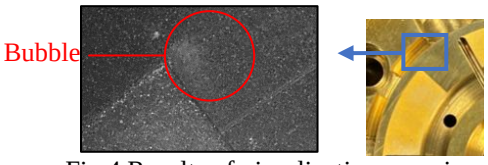


Fig.4 Results of visualization experiments

REFERENCES

[1] Wang, L., Pei, S., Xiong, X., Xu, H., "Investigation of the combined influence of turbulence and thermal effects on the performance of water-lubricated hybrid bearings with circumferential grooves and stepped recesses," J Engineering Tribology, 228, 1, 2014, 53-68.