Measurements of Film Thickness and Pressure Distribution for Optimized Thrust Air Bearing

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Abstract

In this paper, we describe the film thickness and pressure measurement of the optimized thrust air bearing. In our recent study, a new optimization technique of the bearing groove geometry of the hydrodynamic thrust air bearings was proposed and a new groove geometry having a bending curve in outer vicinity of the bearing surface was obtained. Furthermore, in this study, the drastic improvement of the bearing dynamic stiffness was verified by the dynamic characteristic experiment using the original high-speed bearing test rig. However the relative error of the film thickness between the theory and experiment is large compared with that of dynamic stiffness. Consequently, it has been considered that the improvement of the measurement accuracy for film thickness is one of the most important problems. On the other hand, the generation of the negative pressure on the optimized bearing surface has not been confirmed experimentally, and it is also important to verify the negative pressure generation by measurement. Therefore, in this study, we examined the improvement of the measurement accuracy of the film thickness and the pressure measurement of the optimized bearing. As a result, the accuracy of air film thickness is drastically improved applying a newly proposed compensation method and the negative pressure on the optimized bearing can be found experimentally.

1. Introduction

Recently, mechanical systems tend to miniaturize and operate in high speed. Therefore, the supporting bearings which are being used for these devices demanded higher performances. Currently, one of the supporting bearing that is mainly used is the air bearing. This is because the air bearings have a lot of advantages such as low friction, maintenance free and so on. The study related to air bearings has been previously performed by a lot of researchers[1]-[9] and it is known that one of the most important problems is how to enhance the air film stiffness.

In our latest work[10] a new optimization technique of the bearing groove geometry of the hydrodynamic thrust air bearings is proposed, and a new groove geometry having a bending curve in outer vicinity of the bearing surface was obtained. It was clarified that the dynamic stiffness, which is a weak point of the air bearings, is drastically improved by the optimization theoretically and experimentally. On the other hand, the film thickness was inferior in consistency with the theoretical values. Previously the measurements of air film thickness were conducted by some researchers, however as far as the authors know, almost all experimental results are not in good agreement with the theory. Therefore it is important to improve the film thickness measurement method and verify the film thickness of optimized bearing.

In addition, another important characteristic of optimized thrust air bearing is the pressure distribution. This is because the optimized thrust air bearings suppress the air film thickness caused by generating negative pressure on the outer vicinity of the bearing surface. So far, previous research related to the pressure measurement of hydrodynamic air bearings has been limited because of its measurement difficulties compared with other measurements for bearing characteristics such as friction torque, spring coefficient and so on. Moreover, in the previous research[3], [4] the accuracy of the pressure measurement is not enough. Consequently, we carried out measurement of generated pressure distribution on the thrust air bearing surface using specially designed test rig.

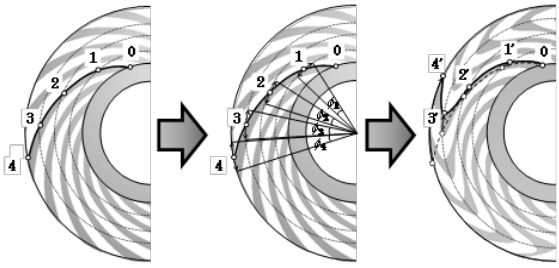

Fig. 1 Optimization of bearing groove geometry