

3222 HDD用小型スラスト空気軸受の特性解析と最適設計
 -最適設計への適用-

Characteristics Analysis and Optimum Design of Small size Thrust Air Bearing
 for Hard Disk Drive
 -Application to Optimum Design -

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Grooved thrust air bearings are widely used for lightly loaded and very high speed machinery. HDD is one of the applications of the machinery. Recently, larger storage capacity and higher transfer speed for HDD is required, hence hydrodynamic oil bearings are adopted. However it has several problems such as high friction torque and low bearing stiffness due to vary the oil viscosity by changing the temperature. In this way, thrust air bearings which make up for the faults is very suitable. However, generally, the stiffness of thrust air bearings is low. Therefore in the design of thrust air bearings, it is important to maximize the stiffness of air film. In this paper the optimum design of groove geometry for small size thrust air bearing to maximize the dynamic stiffness of air film is described and the vibration analysis is conducted to confirm the adaptability and the effectiveness of optimization.

Key Words: Hard Disk Drive, Optimum Design, Thrust Gas Bearings, Bearing, Numerical Analysis

1. Introduction

In recent rapid technology innovations, it is required for informative multimedia related devices to enhance several characteristics. Especially, HDD (hard disk drive) which is widely used for PC and portable audio is expected to increase the storage capacity and transportation speed in the future. Currently, hydrodynamic oil bearings are used in HDD (1). However, because of using oil as lubricant it has some problems, for example, high friction loss at low temperature, low stiffness at high temperature and oil leakage in high speed operations. On the other hand, the air bearings are highly applicable, because of using air as lubricant, and it has many advantages such as low friction, low noise, and light environmental load.

In this paper, which is the continuous research of previous one(2), optimization of the thrust air bearing for HDD and vibration characteristics of the air optimized bearings are investigated.

2. Optimized of bearing

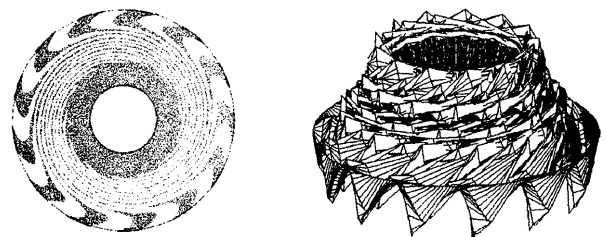
In formulating the optimum design of groove geometry and groove dimension of thrust air bearings for HDD, the objective function is dynamic stiffness. The outer radius r_1 and inner radius r_2 , weight W and rotational speed n_s are given as prescribed values. As for the variable vector of groove geometry design, groove number, seal radius ratio, groove width ratio, groove depth were set up. On the other hand, when the groove geometry changes, the spiral curve is partitioned into equal parts in the r directions (3), (4). Then, it will establish new nodal points and moved to r direction. Several nodal points are connected by spline function. The design variable vector X is defined as follows.

$$X = (\phi_1, \phi_2, \phi_3, \phi_4, H_g, R_r, \alpha, N) \quad (1)$$

The constraints conditions for design variables and state variables, allowable film thickness and damping coefficients are not equal to 0, are expressed as follows.

$$g_i(X) \geq 0 (i = 1 \sim 18) \quad (2)$$

The optimum design problem of thrust air bearing can be formulated as follows



(a) Groove geometry (b) Pressure distribution

Fig.1 Optimized bearing

Table1 Specification of bearings

Parameter	Spiral groove	Optimized
ϕ_1 , deg	0	36.75
ϕ_2 , deg	0	-27.93
ϕ_3 , deg	0	138.11
ϕ_4 , deg	0	112.89
N	16	13
R_r	0.58	0.55
h_g , μm	11	10
α	0.636	0.572