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APPLICATION OF SQP METHOD IN DESIGNING THRUST AIR BEARING FOR HARD DISK DRIVE SPINDLE MOTOR

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ABSTRACT

This article discusses the advantage and potential of air bearing being used in hard disk drive (HDD) to replace the conventional oil-lubricated bearing HDD. The designing of these air-lubricated bearing is conducted with the optimization of bearings groove designs through the combination of direct search and Successive Quadratic Programming (SQP) method. Characteristics compared to the conventional oil-lubricated bearings of a spiral groove showed promising improvements where a new geometry of a modified spiral groove has been found. The new design holds higher performance characteristics compared to the conventional spiral grooved bearings and the calculation results are shown.

1. INTRODUCTION

HDD has been playing a big role in the area of informative multimedia. The shape of these bearings located in HDD spindle motor consists of journal bearing and thrust bearings. In this paper, the bearing design being considered is the thrust bearing located in spindle motors as shown in Fig. 1. In previous research made by Hashimoto et al. [1] proved that the optimization calculated from conventional type of spiral groove and herringbone groove showed a change of shape towards spiral groove shapes eventually. Hence, in this paper, the initial shape being chosen to get high dynamic stiffness is the conventional spiral groove shape.

Japan government also has its own annual aims for the improvements of the media storage performances goals [2]. In order to cope with the storage capacity demands, the current oil-lubricated bearings designs are nearly coming to its limit where high revolutions leads to high friction losses, wear problems oil seal problems due to oil lubrications leakage as the revolutions get higher. Therefore, a much higher revolutionary air bearing with a high dynamic stiffness and does not face these problems as the next bearing is highly expected.

2. OPTIMIZATION OF BEARING

As described in the previous section, the improvement of the performance of the air bearing lies in the improvements of the dynamic stiffness. Therefore, the objective function for HDD thrust air bearing is the dynamic stiffness. Firstly, the line geometry of the initial spiral bearing groove is being divided equally into four nodal points as design variables of $\varphi_1 \sim \varphi_4$ as shown in Fig. 3. In additional, another four design variables is then set making eight design variables consisting of groove number N, seal width ratio r_s, groove depth h_g and groove width ratio α. The vector of the design variables are shown in Eq.1. The constraints conditions for the design variables are shown in the following Eq.2.

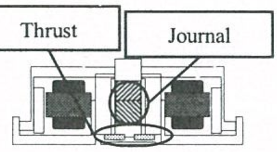


Fig. 1 Bearings in Spindle Motor

Fig. 2 Spiral Groove

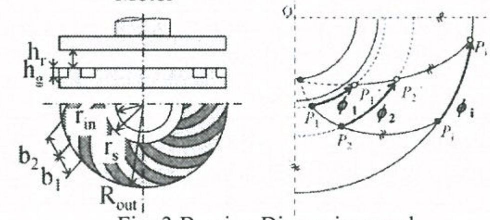
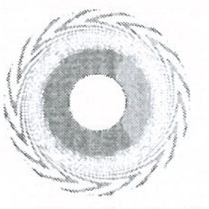


Fig. 3 Bearing Dimensions and Geometries

$$X = (\phi_1, \phi_2, \phi_3, \phi_4, N, r_s, h_g, \alpha) \quad (1)$$
$$g_i(X) \le 0 \; (i = 1 \sim 18) \quad (2)$$



Parameter	Values
φ1(deg)	3.36
φ2(deg)	-18.86
φ3(deg)	135.66
φ4(deg)	87.29

Fig. 4 Results of Optimized Spiral Groove