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Measurement of Film Thickness of Thrust Air Bearing to Consider an Alteration of Temperature

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1. Introduction

Recently, mechanical systems tend to miniaturize and rotates in high speed. Therefore, the supporting bearings which are being used for these devices demand higher performance characteristics. Currently, the supporting bearing that is mainly being used is the air bearing; furthermore, the air bearings have a lot of advantages such as low friction, and maintenance free and so on. As far as the authors know, the study of air bearing has been performed by research [1]-[2]. In previous research, the film thickness was inferior in consistency with the theory compared with other bearing characteristics such as friction torque, spring coefficient and damping coefficient. The method of film thickness measurement was performed by direct measurement of distance between the shaft and the bearing with the eddy current proximity probe. It is considered that the displacement gauge gave large measurement error to actual values because of the effect of heat generation of air film according to the increase of rotational speed.

2. Experimental method and test bearing

To calculate film thickness, the amount of temperature correction is substituted into Eq. (1).

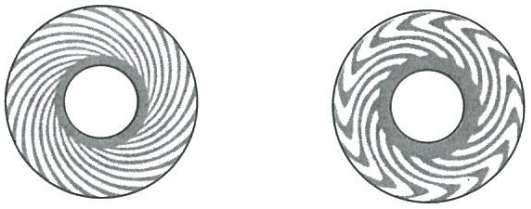
$$h_r = \frac{V_{exp} + \Delta T_n \times T_d - B_V}{G} \qquad (1)$$

Furthermore, T_d is the temperature correction, $V_{\max}$ is the maximum voltage, $V_{\min}$ is the minimum voltage, T_V is the amount of temperature variables, V_{exp} is the voltage reading at the time of the measurement taken, ΔT_n is the amount of temperature variable, B_V is the voltage when the displacement between bearing and rotor is zero and G is the correction value of the eddy current proximity probe. The bearing dimension shown Fig.1 is used in this research. Bearing A is a spiral grooved as shown in Fig.1 (a) and bearing B is the modified spiral grooved bearing as shown in Fig.1 (b).

3. Experimental result

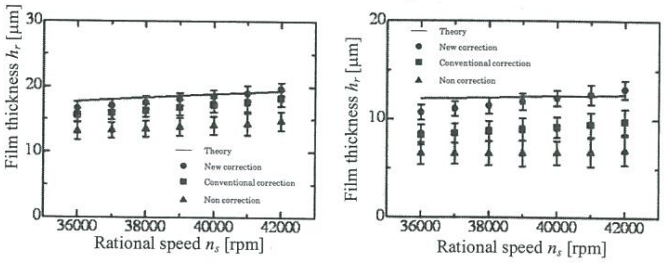
Figure 2(a) shows result of film thickness in spiral grooved. As understood from the figure, the result with correction added had a film thickness rise about 4[μm] compared to the result of non correction. And, it is understood that good agreement is seen between new correction result and predicted result which rise about 2[μm] to compare the conventional correction result.

Figure 2(b) shows result of film thickness in modified spiral grooved. Proposed correction result in this research is understood to raise film thickness in all rotational speeds.



(a) Spiral grooved (b) Modified spiral grooved

Fig. 1 Test bearings



(a) Spiral grooved (b) Modified spiral grooved

Fig.2 Film thickness with rotational speed

The experimental accuracy in spiral grooved was about 11% for non correction result; while there was about 8 % in conventional correction result. On the other hand, it is understood that the new correction method that proposed in this research has the highest accuracy in these methods.

Meanwhile, the experimental accuracy in modified spiral grooved was about 12% for non correction result and there was about 8 % for conventional correction result. On the other hand, good agreement was seen with the new correction method. The newly proposed method in this research measurement accuracy was 4.3%.

4. Conclusion

We proposed new correction method in film thickness measurement in this research. We confirmed that the measurement accuracy was improved between predicted results compared to the conventional film thickness by using this newly proposed correction method.

5. Reference

(1) Hiromu HASHIMOTO, et al, JSME Technical Journal, JAMDSM, 1(1) (2007) , No. 3, pp.102-112.
(2) Hiromu HASHIMOTO, et al, JSME Technical Journal, JAMDSM, 1(1) (2007) , No. 3, pp.306-318