Quantitative monitoring of lubrication conditions in rolling bearings

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1. INTRODUCTION

In order to protect the global environment, low torque and long life of rolling bearings are required. To improve those bearing performances, understandings of practical bearing lubrication conditions (e.g., thickness and breakdown ratio of oil films) are very important. Usually, to measure oil film thickness in EHD (elastohydrodynamic) contacts, optical interferometry methods have been utilized. It is, however, difficult to apply them to measurements for practical bearings because visible lights cannot be transmitted through metal bodies. Recently, the electrical impedance method [1] has been developed, which can measure the thickness and breakdown ratio of oil films simultaneously by applying an alternating voltage to the contact and measuring the modulus and phase of the impedance as a response. In this study, simultaneous measurements of thickness and breakdown ratio of oil films in practical bearings were conducted by using the electrical impedance method.

2. EXPERIMENTAL DETAILS

The ball bearing tester was used for monitoring the lubrication conditions of practical shield bearings (diameter: 22 mm, width: 7 mm). The axial load W was 30 N, and the rotation number N was varied from 140 to 6000 rpm. A poly-α-olefin (viscosity: 19 mm^2/s at 40 °C) was used as a test lubricant. To measure the thickness (h) and breakdown ratio (α) of oil films by using the electrical impedance method, a sinusoidal voltage (RMS amplitude: 1.5 V and frequency: 1 MHz) was applied between the outer and inner ring of bearing respectively. The measured h-values were compared with the Hamrock-Dowson theory [2].

3. RESULTS

Figure 1 shows the measured h-values and α-values for varying rotation number N. Each plot is the result after 1 minute from the start of the test. From the top graph, it is found that when N < 1000 rpm, all the measured h-values are located around the theoretical values. However, when N > 1000 rpm, they are located below the dashed line. Besides, from the bottom graph of Fig. 1, it is indicated that α-values increase monotonically towards unity (= 100%) with decrease in N.

4. CONCLUSION

In this study, simultaneous measurements of thickness and breakdown ratio of oil films in rolling bearings were conducted by using the electrical impedance method. It was suggested that the lubrication conditions of practical bearings could be monitored by using the electrical impedance method quantitatively.

5. REFERENCES

[1] T. Maruyama and K. Nakano, *Tribol. Trans.* (submitted).
[2] B. J. Hamrock and D. Dowson, *Trans. ASME: J. Lubr. Technol.*, **99**, 264 (1977).

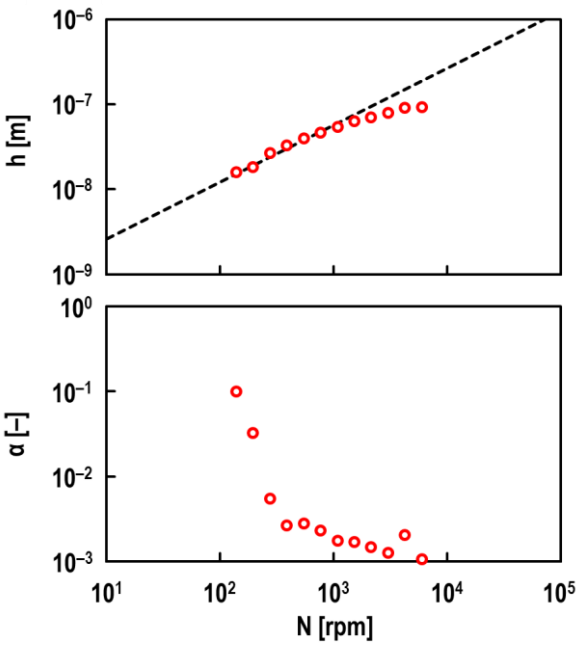

Figure 1. Measured values of oil film thickness h (top), breakdown ratio α (bottom) for varying rotation number N; black dashed line in top graph: theoretical values