

Study on Friction Reduction in Oil-Film Journal Bearings Using Microbubbles

- Application and Evaluation of Novel Oil Grooves -

**Shodai Sakabe¹⁾ Yuki Yoshimura¹⁾ Yuto Yamazaki¹⁾ Koki Gonda¹⁾
Yuki Kawamoto¹⁾ Akihiko Azetsu²⁾ Masayuki Ochiai³⁾**

1) Graduate school of Engineering, Tokai University, Japan

4-1-1 Kitakaname, Hiratsuka, Kanagawa, 259-1292, Japan

2) Dept. of Mechanical Engineering, Tokai University, Japan

4-1-1 Kitakaname, Hiratsuka, Kanagawa, 259-1292, Japan

3) Dept. of Mechanical Engineering, Tokai University, Japan

4-1-1 Kitakaname, Hiratsuka, Kanagawa, 259-1292, Japan

KEY WORDS: Power transmission, Bearing, Microbubble, Fluid lubrication, Tribology (A1)

In recent years, the importance of achieving carbon neutrality in response to global warming has increased the demand for improving the fuel efficiency of automobiles in order to reduce greenhouse gases emitted. The friction loss in engines, which has many sliding parts, accounts for about 20% of the total energy loss in automotive. Consequently, journal bearings used in the rotating parts of engines are also required to reduce friction.

This study focuses on microbubbles as a new reduction method for journal bearings. Microbubbles are known to reduce fluid drag. Yoshimura et al. mixed microbubbles into lubricating oil in a journal bearing and measured the frictional torque in the journal bearing to demonstrate that microbubbles have a friction-reducing effect. Furukawa et al. demonstrated that microbubbles are generated from the negative pressure generated in the wake of the spikes and reduce friction by attaching microscopic spikes inside the bearing that imitate the wings of a dragonfly. Yoshimura et al. showed that the number of microbubbles in the bearing clearance is little and that the void fraction in the bearing clearance is related to the friction reduction. This suggests that the number of microbubbles in the bearing clearance is limited because the void fraction, which is the volume ratio of the gas phase to the liquid phase, is low with the current generation method. Accordingly, it was hypothesized that the shape of the oil supply grooves and the vortex flow generated within them may be factors preventing microbubbles from entering the bearing clearance.

Based on this background, a new oil supply groove design was investigated to increase the number of microbubbles within the bearing clearance. In this paper, we conducted friction torque measurement on journal bearings incorporating the newly developed oil supply groove, with the aim of improving the friction reduction performance of oil-film sliding bearings.

$$k = \left| \frac{T_1 - T_2}{T_1} \right| (\%) \quad (1)$$

In this experiment, the friction reduction rate (k) with and without microbubbles was evaluated. As shown in Equation (1), it was calculated based on the difference between the measured friction torque (T_1) in lubricating oil without microbubbles and the measured friction torque (T_2) in lubricating oil containing microbubbles. Figure 1 shows the relationship between rotational speed and the friction reduction rate. As shown in the figure, the friction reduction rate improved when using the new oil supply groove with a golden spiral shape compared to the conventional semi cylindrical shape, with a maximum improvement of 3.4% at 3,000 rpm. Therefore, these results indicate that modifying the oil supply groove and adopting the golden spiral shape are effective in reducing friction in journal bearings utilizing the microbubbles. It is believed that the reduction effects were caused by changes in flow within the groove due to modifications to the groove shape, which led to an increase in the number of microbubbles entering the bearing clearance.

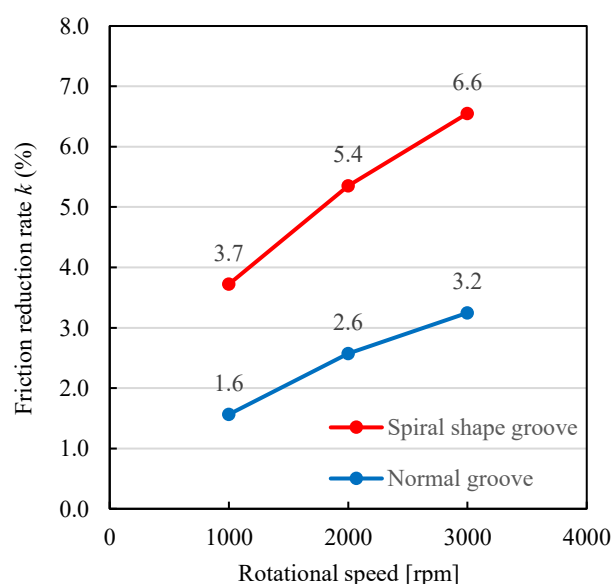


Fig 1 Relationship between rotational speed and friction reduction rate