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Friction Torque and wear of ball bearings oscillation with different greases

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In modern industry, automation and robot technology are key factors for companies in maintaining competitiveness. However, the oscillating motion of robot's bearing is not investigated in detail compared to rotation. Grease lubrication is widely used in these applications in order to simplify the system. In this investigation, the influence of oscillation angle and frequency on bearing performance is studied. Two greases with different NLGI classes are investigated. From this research, the wear and lubrication mechanism changes according to the oscillation angle. The properties of the greases are analyzed.

Keywords: Ball bearings, Oscillation, Grease lubrication

1. Introduction

Oscillating ball bearings may suffer from fretting wear or false brinelling especially under small amplitudes [1]. But the definition of "small amplitudes" is not specific and the bearing performance under big amplitudes has not been adequately studied. For the relatively big oscillation angles, there is a critical angle which is defined as the angle of rotation of ball's race relative to the other one.

In this research, bearing performance around the critical angle and the influence of grease parameters are tested.

2. Methods

The bearing experiments are conducted using the test rig shown in Fig.1. The electrical motor oscillates the test bearings mounted in the test head. The torque sensor outputs the torque and rotation angle of the bearings. The test bearings are lubricated with grease (30% of free volume). There are two kinds of grease which only differ in NLGI class, one has a NLGI class of 2 and the other is NLGI class 1.The critical angle for 6008 is around 60°.

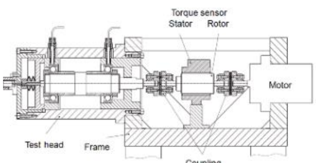

Figure 1: Test rig

Temperature	20°C
Test bearing	6008
Axial Load	2kN
Oscillation frequency	1Hz, 5Hz
Oscillation angle	30°, 90°

3. Result and Discussion

The torque value from the sensor at different oscillation angle and the raceway surface microscopy after the test are shown on Figure 2.

In general, for the oscillation angle of 30°, the torque slightly increases (Fig 2a) and fretting wear is found by the inspection of tested bearings (Fig 2e). Test condition of 5Hz has similar result which is not shown.

For oscillation angle 90°, the torque is stable (Fig 2b) and even slightly decreased for 5Hz (Fig 2e). For both frequencies only some scratches are found (Fig 2f).

The Fig 2d shows the torque comparison of two greases for running 1min to avoid the influence of wear on torque. The torque value is similar and the wear phenomenon is basically the same for 30°. However, a difference in grease behavior is noticeable in the region of low speed (i.e., direction change). Thus it is assumed that the lubricant film decay in the region of low speeds needs to be further analyzed to determine the mechanism leading to different wear.

Whilst wear occurring at larger angles of oscillation is less severe than wear occurring at lower angles (e.g., 30°) the friction torque of the bearings does not differ as noticeably. Furthermore, a change in the friction torque for a running time of 1 hour is negligible in both oscillation angles, whilst the wear mark is already clearly different. Thus, an explanation of the occurring wear needs to be looked at in combination with a still functioning lubricating mechanism. When running the experiments longer the wear changes to severe wear which ultimately leads to an increase of friction torque, which is not noticeable in the incubation period.

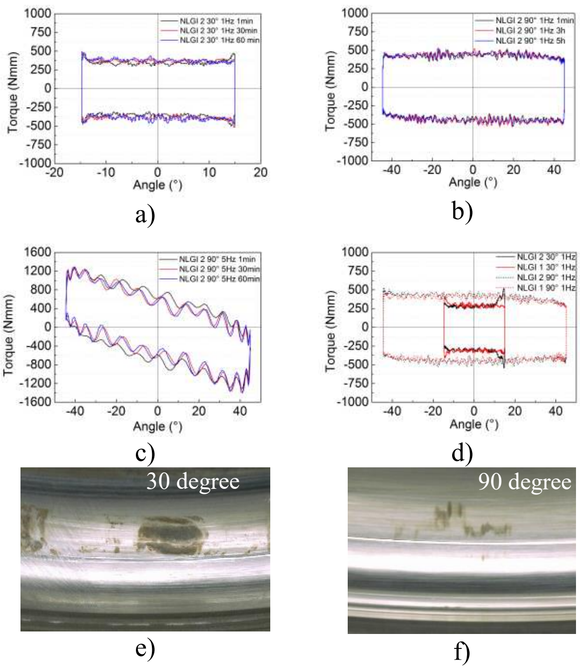

Figure 2: Experimental results

4. References

[1] Maruyama, T. et al. "Differences in mechanisms for fretting wear reduction between oil and grease lubrication." Tribology Transactions 60.3 (2017): 497-505.