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From single contact devices to rolling bearing simulators

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Understanding of the film thickness formation provided by lubricant available at the EHD contact inlet is well known at present stage. Contrary, there is a limited knowledge about mechanisms responsible for lubricant replenishment in real bearing under operation. This is a point where simulation of elastohydrodynamic contact in standard ball-on-disk (BoD) devices could not necessarily be example of conditions in real bearings. Film thickness and starvation severity between classical BoD and newly designed ball-on-ring (BoR) test rig are compared in this study with the use of the fluorescence technique.

Keywords (from 3 to 5 max): grease lubrication, rolling bearing, starvation, replenishment

1. Introduction

Grease lubrication represents a major way for rolling bearings. It provides maintenance-free operation and low friction over wide area of speeds. However, grease lubricated bearing may suffer from severe starvation which is given by balance between loss and replenishment mechanisms of lubricant available in a track. Our understanding of film thickness formation provided by certain lubricant available at the contact inlet is known well at present stage. Contrary, there is a limited knowledge about mechanisms responsible for lubricant replenishment in real bearing under operation. This is a point where simulation of elastohydrodynamic contact in standard BoD devices could not necessarily be example of conditions in real bearings.

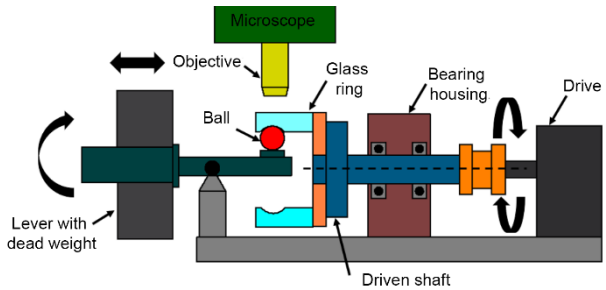

Figure 1: Concept of the BoR test rig

2. Methods

Concept of BoD apparatus was modified to BoR configuration where ring is equipped with inner groove. Direction of the inertial forces much more closely represents real bearing in this configuration. Also, ball and ring conformity was designed to correspond to the real bearing (d/r = 0.52). Concept is shown in Fig. 1. Created EHD contact is observed through glass ring with the use of microscope and fluorescence technique is used to evaluate film thickness in the EHD contact and its vicinity. BoR concept provides contact with increased ellipticity as compared in Fig. 2 with BoD. Initial experiment to prove influence of the geometry to replenishment action was done on both devices and compared. Same amount of lubricant (20 µl) was supplied to the rolling track and the film thickness over speed was observed.

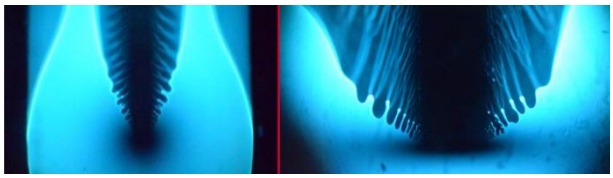

Figure 2: Thickness distribution observed by fluorescence for BoD (left) and BoR (right)

3. Results

Gray line in Fig. 3 represents central film thickness for the BoD apparatus. Behavior follows well known starvation trend where film thickness is decreasing with increasing speed. Blue lines represent film thickness on BoR apparatus. Film thickness tends to stabilize at much higher values than for BoD even for the same volume of the lubricant.

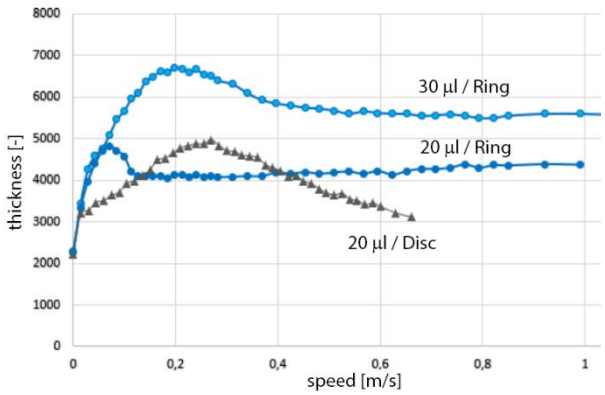

Figure 3: Results of the film thickness over time

4. Discussion

Initial experiments suggest that inertial forces might improve the replenishment action. Lubricant can be dragged away from the contact in the BoD configuration, but BoR provides different orientation of the forces and lubricant is pushed back to the groove rather than dragged away from it. Resulting level of starvation is less severe than for BoD at same operating conditions. Moreover, film thickness tends to increase steadily with increasing speed after short drop. Observed behavior can improve our understanding of the replenishment action in the real bearing as rolling bearings seems to operate reliably at the speed where BoD apparatus already suggests severe starvation.