Detection of Active Grease Reservoirs in Bearings by CFD

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An active grease reservoir in grease lubricated bearings is the location from which lubricating oil is supplied for bearing lubrication. This paper describes a numerical study to detect the active grease reservoirs in grease lubricated bearings through predicting the trajectories of the oil released from grease reservoirs, the oil film formation and transport on the bearing component surfaces.

Keywords: Grease lubrication, active reservoirs, CFD, bearing

1. Introduction

In a grease lubricated bearing, after the churning phase, lubricant grease stays on the surfaces of bearing ring shoulders, cage and seals. These locations form grease reservoirs, from which the grease releases lubricating oil for the bearing contacts. It is known that not all the reservoirs play the same role for bearing lubrication. If a reservoir provides the bearing contacts with the oil, this reservoir is characterized as active with respect to bearing lubrication. Knowing the active grease reservoirs in a bearing enables us to change the bearing design, enhancing the bearing performance.
This work is complementary to earlier experimental work, using a technique based on fluorescence spectroscope [1]. Here a numerical approach is used to detect these active grease reservoirs.

2. Method

In a running bearing, after the churning phase where macroscopic grease flow takes place, grease stays stationary on some locations inside the bearing and bleeds base oil. This phase is called the bleed phase where there will be no bulk grease flow anymore. The active grease reservoirs can be detected by focusing on the flow of the bled oil only. If the oil bled from a specific grease location finally ends up in a bearing contact (meaning the oil contributes to the bearing lubrication), this grease reservoir is "active" in terms of bearing lubrication.
The CFD (Computational Fluid Dynamics) method is employed to predict the trajectories of bled oil, oil film formation and transport. In the CFD model applied in this work it is assumed that the grease reservoirs serve as oil sources, which continuously provide oil to the bearing in the form of oil droplets. Upon entering into the bearing, the oil droplets flow, driven by the drag force of the air flow and the gravity. When oil droplets impinge on a bearing element surface, they convert into lubricating film. Subsequently, the film moves on the surface of the bearing element because of bearing rotation.
The CFD model in this work includes the full bearing geometry and bearing kinematics. Two bearings were studied, i.e. a deep groove ball bearing and an angular contact ball bearing. Two CFD methods were applied for the study of each bearing. The first is the Lagrangian method, simulating only the droplet trajectories. The second method is a combination of Lagrangian trajectories and oil film transport.

3. Results

For the angular contact ball bearing, a potential active reservoir on the outer ring shoulder is identified. The CFD results show that the oil droplets released from the grease on the outer ring shoulder form oil films on the balls. Then the oil films are transported to the raceway contacts by the ball rotation, as shown in Figure 1. The closer the oil is released to the raceway, the more and faster the oil reaches the raceway contacts. The result agrees with the experimental measurement.
For the deep groove ball bearing, the CFD simulations show that the oil droplets released from the seals move in both the circumferential and axial directions. The oil droplets can reach the outer ring raceway, demonstrating that the grease reservoirs on the seals are active reservoirs in the deep groove ball bearing.

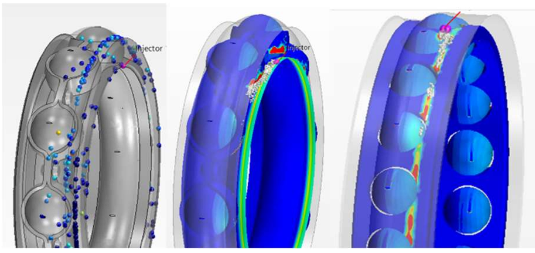

Figure 1 Oil droplet trajectory and oil film transport in a deep groove ball bearing and angular contact ball bearing

4. References

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