7th World Tribology Congress, WTC 2022
July 10-15, 2022, Lyon, France

OBSERVATION OF A MODIFIED SUPERFICIAL LAYER ON HEAVILY LOADED OSCILLATING BEARING UNDER GREASE LUBRICATION

L. Frache [a,b*], R. Sarlin [b], D. Philippon [a], N. Bouscharain [a], Y. Maheo [b], F. Massi [c,d],

[a] LaMCoS – INSA de Lyon, Villeurbanne – France
[b] SKF Aerospace, Châteauneuf-sur-Isère - France
[c] DIMA - University of Rome "La Sapienza", Rome – Italy
[d] InTriG – International tribology group, Villeurbanne - France
*Corresponding author: lucas.frache@insa-lyon.fr

Highly loaded greased oscillating bearings are here investigated. Encountered in applications as aeronautic (ailerons, actuators, etc.) or wind turbine (pitch control), such conditions impose a starved lubrication regime, while the contact pressures largely overcome the bearing material yield stress. Preliminary studies have highlighted that a grease lubrication is require to preserve the bearing integrity, depending on the grease formulation. To fulfill the lubrication comprehension, together with an extreme surface XPS analysis, three cross-sections made by nanomachining process have been investigated by TEM. Those observations reveal the presence of a modified layer at the contact greased interface.

Keywords: high contact load, modified layer, oscillating bearings, grease

1. Introduction

Problematics related with oscillating bearings have emerged from the aeronautic and the wind turbine fields. Hence, pitch control actuators require to transmit massive loads at low speeds through bearings. Those operative constrains result to high contact pressures of order of several GPa, under a starved lubrication regime, hardly provided by dedicated greases. Under those conditions, severe superficial failures should overcome [2]. However, recent studies have revealed that the lifetime of the bearing is characterized by a long steady state, where no relevant signs of degradation are observed on the surfaces until a sudden damage occurs [1]. Those results let assume that, despite the lack of a lubricant film at the contact interfaces, the grease succeed in protecting surfaces from superficial wear, leading to a fatigue failure commonly observe in EHL regime [2].
By using a multi-technique approach, the study aims to investigate the superficial accommodation mechanisms that lead to the surface protection.

2. Methods

To study interfaces in high loaded oscillating contacts, an overall approach, assembling endurance tests and specific observations surface [1, 2], has been used.

2.1. Experimental setup

Tests are conducted on a dedicated bench “R2”[1, 2]. An oscillating angle motion of 40° at a frequency of 5Hz has been applied on a greased deep groove ball bearing loaded to reach 4GPa of maximum contact pressure for the most loaded ball. Then, the test is stopped during the steady state phase and the bearing is analyzed.

2.2. Samples preparation

Here, the study is focused on the inner ring of the bearing, where contacts pressures are the higher. The contact surfaces have been observed by scanning electron microscopy (SEM) and XPS (X-Ray Photoelectron Spectroscopy) to identify their topography, structure and composition. Then, deeper analyses have been conducted on three lamellae, nanomachined (FIB) on the inner ring and observed with a transmission electron microscope (TEM).

3. Discussion

Smoothed areas have been observed on the plasticized machining grooves of the contact surfaces, mainly close to the reversing points of the most loaded rollers and their neighbors. XPS measures have confirmed the formation of a layer based on third body elements at the interface. Fulfil with the TEM observations of the FIB lamellae, the layer thickness and composition depend on the localization on the contacting surfaces.
Those analyses have proved that surfaces can be protected by a formation of a solid film based on grease elements reacting with the surfaces under extreme pressure solicitations.

4. References

[1] E. H. Komba et al., « Experimental damage analysis in high loaded oscillating bearings », Tribol. Int., vol. 102, p. 507-515, oct. 2016.
[2] I. El-Thalji and E. Jantunen, « A descriptive model of wear evolution in rolling bearings », Eng. Fail. Anal., vol. 45, p. 204-224, oct. 2014.
[3] I. Ghezzi et al., « Damage evolution and contact surfaces analysis of high-loaded oscillating hybrid bearings », Wear, vol. 406-407, p. 1-12, juill. 2018.