Loss-of-lubrication in aeronautical ball bearings

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Loss-of-lubrication occurs when the lubricant supply is entirely removed from an initially lubricated contact. This phenomenon can lead to contact failure and has to be under control in aeronautical subsystems such as ball bearings. This experimental study aims to a better understanding of loss-of-lubrication in aeronautical ball bearing. The tests are performed on a ball-on-disk tribometer, and the contact is monitored with coefficient of friction and electrical contact resistance (ECR) measurement. These results are combined with microscopy analysis of the worn surfaces in order to highlight the main steps leading to contact failure. Different material pairs, roughness and lubricant are compared.

Keywords (from 3 to 5 max): Loss-of-lubrication, starved lubrication, aeronautical ball bearings, ball-on-disk tribometer, ECR

1. Introduction

In lubricated contacts, loss-of-lubrication consists in a specific case of lubricant starvation where the lubricant supply is entirely removed. Loss-of-lubrication results in film thickness reduction and can lead to contact failure. In aeronautics, failure due to loss-of-lubrication is a major issue to deal with since it can lead to emergency landing or even crash [1]. Power transmission manufacturers guaranty the good operation of their systems in loss-of-lubrication conditions for a given amount of time. Increasing this time before failure would improve the safety of the aircraft users. As power transmission subsystems, aeronautical bearings and their behaviour under loss-of-lubrication are of interest. This study aims to a first understanding of loss-of-lubrication in aeronautical ball bearings.

2. Materials and methods

The multiple contacts in a ball bearing increase the difficulty to differentiate the impact of each contact on the others. Indeed, a ball bearing assembly does not allow to monitor each contact separately. Therefore, this study uses a ball on disk tribometer to study loss-of-lubrication at the contact level between the ball and the bearing race (Fig.1). The selected tribometer to run the tests is a mini traction machine (MTM2) from PCS Instruments.

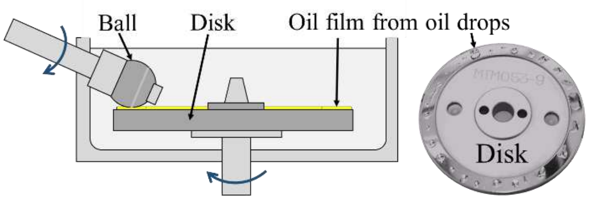

Figure 1: MTM2 for loss-of-lubrication tests

Different test cycles and conditions to reproduce a contact between a ball and the bearing track after the removal of the oil supply are tested and discussed. The contact is monitored with a tangential force transducer and contact resistance measurement (ECR) (Fig.2). Different material pairs, such as steel-steel and hybrid steel-ceramic are compared, for two different steels, two disk's roughness and two lubricants. Ball and disk worn surfaces are studied by optical and scanning electron microscopy.

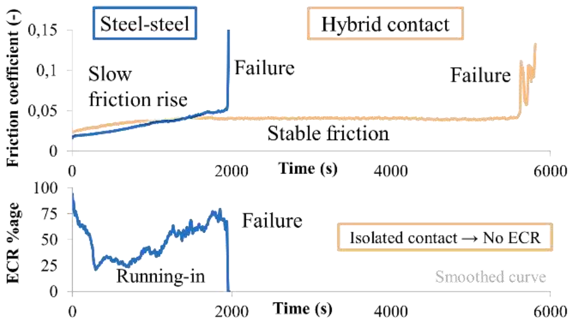

Figure 2: Friction and ECR curves for 2 loss-of-lubrication tests (steel-steel contact and hybrid contact)

3. Discussion

This test highlights the main steps between the beginning of a loss-of-lubrication phase and the contact failure, such as surface running in (Fig.2). Interrupted tests complete this result by giving access to the surfaces at different steps of a test.

The results of the different material pairs with several variations lead to a ranking of the most suited configurations for reducing the impact of loss-of-lubrication.

4. Acknowledgments

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5. References

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