DLC Coating on Axially Floating Bearings for More Electric Aircrafts

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Ball bearing selection is critical to a system performance, especially in aerospace industry. Most of the studies focused on improving the bearing performances by reducing the friction between the rolling elements, but little on its behavior within its final assembly. This paper investigates fretting and galling between a bearing liner and a bearing. This study describes a surface engineering method through different axis to improve the design by functionalizing the surface in order to reduce the damage to an acceptable level.

Keywords (from 3 to 5 max): tribology, DLC coating, axially floating bearing, galling, solid lubricant

1. Introduction

Bearings have always been a key component in mechanical engineering systems. In the aerospace industry, bearings are used in different applications with the same design intents: carry loads, reduce friction and stabilize the position of rotating machine parts, especially at high speed (+10 000 rpm). Most of the research studies to reduce the friction of a bearing are focused on the lubrication (oil, grease) and coatings on the cage [1]. Fewer studies have been conducted on the external surfaces of the bearings. This paper presents the method that has been followed to select a technical solution to stop galling between the outer ring of the axially floating ball bearing and the bearing liner in which it is fitted. This solution is based on a combination of a solid lubricant and an assembly paste, which has been proven an improvement on the current design.

2. Possible In-service behavior

Within the aerospace industry, not all the systems and applications are oil lubricated. Depending on the design, the customer specification and the weight targets, an air cooled design is the best option. However, this can lead to an increase of tribological issues. In this paper, an air-cooled electrical generator running at 17000 rpm is studied. The purpose of the research is to increase the time between overhauls by 150%. Some units after completion of a development test were presenting fretting corrosion and galling as shown in Figure 1. The challenge was to define a suitable solution, fit for flight, to reduce the galling observed and increasing the number of flight hours of the generator.

Figure 1: Galling on a bearing liner in MRO

3. Proposed Method and Tested Solutions

The research initially focused on a relatively simple change: selecting better materials for the bearing and the bearing liner without adversely affecting the weight and performances of the unit. However, this was not enough to improve the performances of the system. It was therefore necessary to functionalize the surface by applying a Diamond Like Carbon (DLC) coating either the bearing liner (where the bearing sits) or the bearing outer ring. Both options have been investigated. The last option was to adjust the selection assembly paste in order to reduce the friction between the bearing and the bearing liner during assembly but also while in service. All options were investigated and faced different issues, as either design, cost or quality of the produced parts. The change of lubrication of the paste helping the assembly of the unit has been also investigated. The paper details all the above options and how the final solution has been selected.

4. Discussion and Conclusion

Several solutions were investigated and some of these has been tested directly on a unit to be representative of the in service conditions. A combination of several solutions were implemented and demonstrated efficient to increase the life of the product in accordance with the defined requirements. Figure 2 shows the bearing liner surface after the completion of 3000 hours of endurance test on a drive stand. The unit is performing as expected and without any sign of galling or other unacceptable damage.

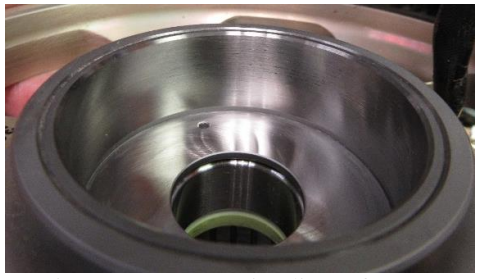

Figure 2: New Bearing liner after test

5. References

[1] M. Marquart et al., “Enhancing the lifetime of MoS_2-lubricated ball bearings”, Wear, 303, 1-2, 2013, 169-177