Improving Wear and Fretting Characteristics of a Rotorcraft Transmission Bearing and Case Interface with Fiber Reinforced Aluminum (FRA) Liners

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ABSTRACT

A study has recently been performed to investigate improvements between the interfaces of the transmission case and rolling element bearings that provides for extended wear life. This study included demonstration testing of the improvements shown in wear and fretting characteristics at the bearing/case interface by using a Fiber Reinforced Aluminum (FRA) liner. This liner material is an engineered metal matrix composite that exhibits the best mechanical properties of each of the constituent materials, and provides enhanced capabilities in terms of structural, thermal, and chemical performance. An additional benefit of using FRA liners is a reduced weight compared to traditional steel bearing liners. This weight improvement is achieved with little to no redesign work, and without increasing manufacturing complexity. With proper sizing, the FRA bearing liners are a direct replacement for the existing part. This paper recollects all the results of this recent study, as well as plans for the future.

INTRODUCTION

Bearing liners are currently used in rotorcraft gearboxes to reduce wear between the bearing race and housing during aircraft operation, and offer a repairable interface during initial production and overhaul. The more commonly used steel liners exhibit wear and fretting, are heavy, and have a lower coefficient of thermal expansion (CTE) than the cast aluminum or magnesium housings used in the rotorcraft industry. This can produce greater than desired stresses at low case temperatures and potential loss of interference fit at elevated operating temperatures. Another drawback is that the carburized outer layer is removed from the steel liner during the post-assembly grinding operation leaving the steel liner without the surface hardness desired in the design.

Fiber Reinforced Aluminum (FRA) bearing liners, manufactured at Triton Systems, are being developed as part of the Future Advanced Rotorcraft Drive System (FARDS) program as a direct replacement for the existing steel liners that are commonly used today in rotorcraft transmissions. As will be shown in this paper, the FRA bearing liners outperform steel and aluminum during fretting and wear tests by more than 3X, are one third the weight of steel, provide superior uniformity in hardness and machinability, maintain the designed interference fits during thermal cycling, and may provide additional corrosion protection in aluminum or magnesium transmission housings.

This paper will also show results of insertion and removal testing of the FRA liners, and discuss future technology readiness level (TRL) 6 testing in the FARDS main rotor demonstrator gearbox that will demonstrate the durability and survivability of the FRA liners during endurance tests and in loss-of-lube scenarios.

LINER PERFORMANCE

FRA bearing liners are planned to be demonstrated within the FARDS main rotor demonstrator gearbox in 2015. Figure 1 shows an example of the location of these liners within the demonstrator gearbox. Since wear and fretting are the typical failure modes for liners, the performance of the FRA liners needed to be evaluated before insertion into the FARDS demonstrator. These wear and fretting component tests, performed under the FARDS program, demonstrated the potential of the FRA liners to extend wear life. Moving from steel to fiber reinforced aluminum required only tolerance changes in the liner design to allow correct engagement for the difference in CTE. Increased manufacturing complexity for assembly is not anticipated as the liners are installed using common methods.

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