

RATIONALE

An industry survey determined that there is a concern over micropitting in aviation turbine bearings and gears. While there is no evidence that micropitting is associated with existing AS5780 qualified oil formulations, it is worthwhile establishing a screening method to document qualified and new candidate formulations for micropitting performance.

1. SCOPE

This method is designed to evaluate the micropitting performance of currently available and future aviation turbine oil formulations. Drawing on previously performed tests documented in AIR6989, the method comprises of three rings rotating against a rotating central roller configuration using the standard, commercially available PCS Instruments Micropitting Rig (MPR). A test profile has been developed between industry and academia that relies on standard, commercially available test specimens.

2. APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AIR6989 Micropitting of Bearings and Gears in Aviation

AS5780 Specification for Aero and Aero-Derived Gas Turbine Engine Lubricants

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM E92 Standard Test Methods for Vickers Hardness and Knoop Hardness of Metallic Materials

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3. APPROACH

3.1 Test Equipment Overview

The MPR (Figure 1) is a computer-controlled three-contact disc machine in which there are three “counterface” rings of equal diameter positioned at 120 degrees apart with a smaller diameter central roller located in the middle and in contact with all the rings (Figure 2). This arrangement allows the test roller to be subjected to a large number of rolling contact cycles in a short period of time and, hence, significantly reduces testing time. At a typical entrainment speed of 3.5 m/s, the central test roller will experience approximately one million contact cycles per hour.

The instrument has an onboard microprocessor, which allows speed, slide-roll ratio, sump oil temperature, and load to be automatically controlled. Two servo-controlled motors are used to control the speeds of the rings and the roller separately, allowing a wide range of slide-roll ratio and entrainment speeds to be set. It is therefore possible to perform a series of test steps under controlled conditions for the study of the effect of lubricant composition on micropitting, macropitting, or failure load testing.

A dip lubrication system is employed as a means to supply lubricant into the contacts. The test requires a relatively small volume (150 mL) of oil into which the two lower rings are dipped. An electric cartridge heater is used to adjust the temperature of the test chamber, which in turn heats up the test lubricant. A temperature probe is inserted into the test chamber with the tip of the probe close to one of the ring-roller contacts (Figure 2).

Load is applied by means of a motorized ball-screw, acting through a loading arm. The movement of the ball-screw causes the loading arm to apply a downward load on the top ring, which can move in a vertical direction while the lower rings remain fixed. Due to the contact configuration, the force on each ring-roller contact is equal. During the test, the load is gradually increased in steps to reach the designated running load. A strain gauge is attached on the loading arm to control the applied load.

The test head design allows a test to be stopped at any time, the load removed, and the rotation stopped. The central roller can then be withdrawn for inspection, without disturbing either the lubricant or the three rings. The roller specimen can then be placed back in position and the test can continue. This is particularly useful in the study of both micropitting and macropitting, where physical examination of the specimen is essential to establish the rate of progression of damage.

The rig has comprehensive safety features. A test will be automatically stopped when any preset limit for temperature, vibration level, or friction is exceeded. The temperature limit uses the lubricant bulk temperature to trigger the shutdown of a test. In addition, there is also a safety alarm temperature sensor inside the test head. Vibration and friction coefficient limits are detected using an accelerometer mounted on the test head and a torque sensor respectively.