SAE Aerospace
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AEROSPACE RECOMMENDED PRACTICE

SAE ARP5448/3

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Plain Bearing Low Speed Oscillation Test

1. SCOPE:

1.1 Purpose:

This test method outlines a standard procedure for performing unidirectional load dynamic testing of self-lubricating bearings at room temperature, elevated temperature or sub-zero temperature, dry or contaminated with fluids. The wear data from these tests is to be used for qualification and to establish bearing design criteria.

1.2 Classification:

Bearings covered by this test method shall be plain spherical bearings, which are self-aligning or plain sleeve bearings.

2. REFERENCES:

There are no referenced publications specified herein.

3. DEFINITIONS:

Not applicable.

4. GENERAL REQUIREMENTS:

4.1 Test Apparatus:

4.1.1 Test Machine: The test machine shall be capable of applying a unidirectional load of controlled magnitude to the bearing race while the ball (for spherical bearings) or shaft (for sleeve bearings) is oscillated through a prescribed angle. Loads shall be capable of being maintained within +3%/-0% of the test requirement. Angle of oscillation shall be capable of being maintained within ±0.5° of the test requirement. The bearing shall be mounted to place the shaft in double shear with a minimum of bending. The machine should include the following accessory equipment for complete testing capability.

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4.1.1.1 Bearing Holders: Appropriate size bearing holders shall be made of steel. Provisions to bush these holders are recommended.

4.1.1.2 Test Shafts: Appropriate size test shafts shall be made of steel with a hardness of Rc 45 minimum or Cres, PHI3-8Mo, condition H-950, and may be chrome plated or nickel plated. When testing sleeve bearings, it is acceptable for some test machine setups to require bushings to act as an inner race. All further statements about shafts shall also apply to shaft/bushing combinations. Cres is recommended for shafts because of its increased fatigue properties. Shafts for testing sleeve bearings shall have 8 Ra surface finish on the outside diameter and be polished after grinding.

4.1.1.3 Temperature Heating System: A temperature heating system shall permit heating the test bearing to a controlled temperature at the ball liner interface for spherical bearings or shaft liner interface for sleeve bearings. One approach to accomplish this when testing spherical bearings is to grind a small groove in the test bearing ball or race face and tack weld a thermocouple in it. When sleeve bearings are tested, an inner sleeve or bushing slightly wider than the bearing with similarly attached thermocouple acts as the inner. Locate the thermocouples within ±45° of the center of the load zone. Temperature monitors/controllers shall be accurate within ±5 °F.

4.1.1.4 Temperature Cooling System: A temperature cooling system shall permit cooling the test bearing to a controlled temperature at the ball liner interface for spherical bearings or shaft liner interface for sleeve bearings. The preferred system consists of an insulation box around the test station and introduction of N_2 or CO_2 as a cooling medium. Temperature shall be monitored/ controlled as in 4.1.1.3.

4.1.1.5 Radial Displacement Indicator: A dial indicator or electronic pickup device, accurate within 0.0002 inch, shall be mounted to permit measurement of any radial movement of the race with respect to the ball for spherical bearings or radial movement of the journal with respect to the shaft for sleeve bearings. The preferred system is to measure bearing holder displacement with respect to the test shaft. The next preferred method is to measure bearing holder displacement with respect to some fixed surface. The least preferred method is measurement at some remote site.

4.1.1.6 Liquid Contaminator System: A liquid contaminator system shall introduce liquid contaminants to each side of the test bearing during dynamic testing. This system shall have provisions to accurately regulate the flow rate of the contaminant. Provisions shall also be made to catch the fluids.

4.1.1.7 Cycle Counter: Provisions shall be made to count cycles.

4.1.1.8 Load Monitor: Provisions shall be made to monitor load.

4.1.1.9 Torque Monitor: Provisions shall be made to monitor torque to rotate the test spindle for reference purposes. It is advisable for the test laboratory to have previously determined the torque attributable to the support bearings of the test rig spindle in order to isolate torque due to the test bearings.

4.1.2 Calibration: Calibration of the instrumentation shall be in accordance with manufacturer's specifications and shall be within limits at the time of the test.

4.1.3 Equipment Variations: Variations to the test equipment and associated methods required herein are permissible provided the procuring activity is provided with sufficient calibration data to verify the accuracy of the test conditions/results.

4.2 Test Specimen:

Spherical bearings shall be prepared for testing by notching or otherwise permanently marking the outer race to identify the center of load zone. If the temperature control method specified in 4.1.1.3 is utilized, spherical bearings shall be prepared for elevated temperature testing by grinding a notch in one ball or race face and attaching an appropriate thermocouple in it. Sleeve bearings shall have the center of the load zone identified on the metallic sleeve.

5. DETAILED REQUIREMENTS:

5.1 Procedure:

The test bearing shall be installed in an appropriate bearing holder with a mark identifying the center of the load zone.

Fit between bearing O.D. and holder shall be 0.0000 to 0.0010 clearance fit for spherical and 0.0000 to 0.0010 interference fit for sleeve bearings. Fit between bearing I.D. and shaft for both spherical and sleeve shall be 0.0000 to 0.0010 clearance fit.

The bearing holder, bearing and shaft shall be installed in the bearing test machine and mounted to place the shaft in double shear with a minimum of bending. Bearing support and adapter bushings should be tight against the ball face of spherical bearings, but clamp up on the ball need not be controlled provided it is not excessive. Dial indicator or electronic pickup device shall be installed.

The specified oscillating load shall be applied and held statically for 15 minutes minimum. At the end of this time the dial indicator or electronic pickup device shall be "zeroed."

The test shall be run in such a manner, that the ball for spherical bearings, or shaft and/or bushing of sleeve bearings, is oscillated ±X° minimum from the zero position. X° shall be stated in the test plan. A cycle shall consist of oscillation from zero to +X° and return to zero to -X° and return to zero. Rate of oscillation for ambient temperature tests shall be specified in the test plan.

The oscillation test shall be started. Readings of wear, temperature (for elevated and sub-zero tests) and cycle count shall be recorded at the beginning of the test and at sufficient intervals to plot a graph of wear (ten-thousandths of an inch) versus life (cycles). Upon completion of the test, the loaded breakaway torque shall also be measured if specified in the test plan.