Designation: D4170 – 16

Standard Test Method for Fretting Wear Protection by Lubricating Greases[1]

This standard is issued under the fixed designation D4170; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This test method evaluates the fretting wear protection provided by lubricating greases.

1.2 The values stated in SI units are to be regarded as the standard.

1.2.1 *Exception*—Other units are provided for information only.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific warning statements, see 7.2 and 9.2.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

Test Methods for Rating Motor, Diesel, and Aviation Fuels; Motor Fuels (Section I), Reference Materials and Blending Accessories (Annex 2), Reference Fuels (A2.7.3.3), and Table 32 (Specification for *n*-Heptane Motor Fuel)

2.2 *Military Standard:*[3]

MIL-S-22473D Sealing, Locking and Retaining Compounds, Single-Component

3. Terminology

3.1 *Definitions:*

3.1.1 *fretting wear, n*—a form of attritive wear caused by vibratory or oscillatory motion of limited amplitude characterized by the removal of finely-divided particles from the rubbing surfaces.[4]

3.1.1.1 *Discussion*—Air can cause immediate local oxidation of the wear particles produced by fretting wear. In addition, environmental moisture or humidity can hydrate the oxidation product. In the case of ferrous metals, the oxidized wear debris is abrasive iron oxide (Fe_2O_3) having the appearance of rust, which gives rise to the nearly synonymous terms, fretting corrosion and friction oxidation. A related, but somewhat different phenomenon often accompanies fretting wear. False brinelling is localized fretting wear that occurs when the rolling elements of a bearing vibrate or oscillate with small amplitude while pressed against the bearing race. The mechanism proceeds in stages: (1) asperities weld, are torn apart, and form wear debris that is subsequently oxidized; (2) due to the small-amplitude motion, the oxidized detritus cannot readily escape, and being abrasive, the oxidized wear debris accelerates the wear. As a result, wear depressions are formed in the bearing race. These depressions appear similar to the Brinell depressions obtained with static overloading. Although false brinelling can occur in this test, it is not characterized as such, and instead, it is included in the determination of fretting wear.

4. Summary of Test Method

4.1 The tester is operated with two ball thrust bearings, lubricated with the test grease, oscillated through an arc of 0.21 rad (12°), at a frequency of 30.0 Hz (1800 cpm), under a load of 2450 N (550 lbf), for 22 h at room temperature (Note 1). Fretting wear is determined by measuring the mass loss of the bearing races.

NOTE 1—Arc, frequency, and load are factory-set operating conditions and should not be altered. The load spring constant may change over an extended time period. Spring calibration should be checked periodically and, if necessary, a suitable shim should be fabricated to obtain the required load (±3 %) at the assembled length of the spring.

5. Significance and Use

5.1 This test method is used to evaluate the property of lubricating greases to protect oscillating bearings from fretting wear. This method, used for specification purposes, differentiates among greases allowing low, medium, and high amounts of fretting wear under the prescribed test conditions. The test has been used to predict the fretting performance of greases in wheel bearings of passenger cars shipped long distances.[5] Test results do not necessarily correlate with results from other

[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.G0.04 on Functional Tests - Tribology.

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[2] See 1998 *Annual Book of ASTM Standards*, Vol 05.04.

[3] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098.

[4] *NLGI Lubricating Grease Guide*, 3rd edition.

[5] Verdura, T. M., "Development of a Standard Test to Evaluate Fretting Protection Quality of Lubricating Grease," *NLGI Spokesman*, Vol XLVII, No. 5, August 1983, pp. 157–67.

*A Summary of Changes section appears at the end of this standard

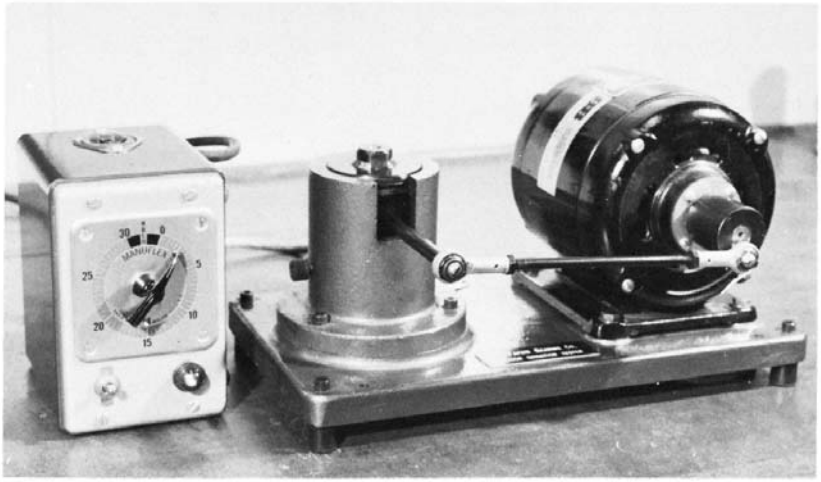

FIG. 1 Fafnir Friction Oxidation Tester and Time Switch

types of service. It is the responsibility of the user to determine whether test results correlate with other types of service.

6. Apparatus

6.1 *Falex Fretting Wear Tester, Model F-1581,* [6,7] as purchased and illustrated in Figs. 1 and 2.

6.2 *Spring Guide,* conforming to description in Fig. 3, if not supplied with tester.

6.3 *Test Bearings,* [8,7] of the ball thrust type having an inside diameter of 16.00 mm ± 0.025 mm (0.630 in. ± 0.001 in.), an outside diameter of 35.69 mm ± 0.025 mm (1.405 in. ± 0.001 in.), and assembled height of 15.75 mm ± 0.25 mm (0.620 in. ± 0.010 in.) and equipped with nine 7.142 mm (0.281 in.) diameter balls in a pressed steel retainer; all surfaces (except retainer) to be ground. Different surface finishes are provided on commercial bearings. Bearings with ground surfaces are lustrous; tumbled bearings appear slightly dulled or grayish. Bearings with ground races, as specified in 6.3, are required to obtain correct results. Tumbled bearings with reground races are satisfactory. Magnification should be used to inspect the races to verify that they have been ground. Part-number bearings[8,7] are provided with ground races. A drawing of the test bearing, giving complete, detailed dimensions and specifications is available in RR:D02-1159.[9]

6.4 *Vibration Mount,* [10,7] upon which the tester is placed.

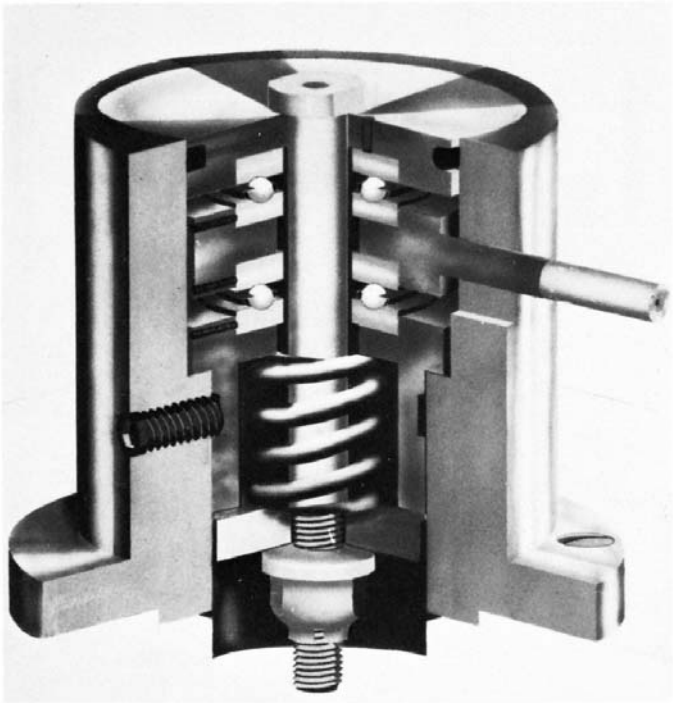

FIG. 2 Chuck and Housing Assembly

6.5 *Time Switch,* (optional) shown in Fig. 1 and described in detail in Fig. 4, or a commercial equivalent.

6.6 *Ultrasonic Cleaner.* [11,7]

6.7 *Analytical Balance* having a capacity of about 100 g and with a minimum sensitivity of 0.1 mg.

7. Reagents and Materials

7.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that

[6] Falex Fretting Wear Tester, formerly known as the Fafnir Friction Oxidation Tester, is available from Falex Corp., 1020 Airpark Dr., Sugar Grove, IL 60554.

[7] The sole source of supply of the apparatus known to the committee at this time is listed. If you are aware of alternative suppliers, please provide this information to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

[8] Andrews (Part No. 06X65) have been found to be satisfactory. Prepared bearings (part number F-1581-50 (formerly FL-1081)), that is, with set screw flat (see 8.1), are available from Falex Corp., 1020 Airpark Dr., Sugar Grove, IL 60554.

[9] Supporting data (the results of the cooperative test program, from which these values have been derived) have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1159.

[10] Isomode Vibration control Pad No. 3451801 has been found satisfactory and is available from rubber products suppliers.

[11] A Bransonic 2200 cleaner (Branson Ultrasonics Co., Danbury, CT 06813) having a capacity of about 3 L (¾ gal) operating at a frequency of about 55 kHz, with a power input of about 125 W, has been found satisfactory.