Designation: D 5707 – 98

An American National Standard

Standard Test Method for Measuring Friction and Wear Properties of Lubricating Grease Using a High-Frequency, Linear-Oscillation (SRV) Test Machine[1]

This standard is issued under the fixed designation D 5707; 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 covers a procedure for determining a lubricating grease's coefficient of friction and its ability to protect against wear when subjected to high-frequency, linear-oscillation motion using an SRV test machine at a test load of 200 N, frequency of 50 Hz, stroke amplitude of 1.00 mm, duration of 2 h, and temperature within the range of the test machine, specifically, ambient to 280°C. Other test loads (10 to 1400 N), frequencies (5 to 500 Hz) and stroke amplitudes (0.1 to 3.30 mm) can be used, if specified. The precision of this test method is based on the stated parameters and test temperatures of 50 and 80°C. Average wear scar dimensions on ball and coefficient of friction are determined and reported.

1.2 This test method can also be used for determining a fluid lubricant's ability to protect against wear and its coefficient of friction under similar test conditions.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 217 Test Method for Cone Penetration of Lubricating Grease[2]

D 4175 Terminology Relating to Petroleum, Petroleum Products, and Lubricants[3]

D 5706 Test Method for Determining Extreme Pressure Properties of Lubricating Greases Using a High-Frequency, Linear-Oscillation (SRV) Test Machine[4]

G 40 Terminology Relating to Wear and Erosion[5]

2.2 *Other Standard:*

DIN 17230 Roller Bearing Steels[6]

DIN 51 834 Testing of Lubricants: Mechanical–Dynamic Test in the Oscillation Friction Apparatus[6]

3. Terminology

3.1 *Definitions:*

3.1.1 *break-in*, *n*—*in tribology*, an initial transition process occurring in newly established wearing contacts, often accompanied by transients in coefficient of friction or wear rate, or both, which are uncharacteristic of the given tribological system's long-term behavior. **G 40**

3.1.2 *coefficient of friction*, *n*— *in tribology*, the dimensionless ratio of the friction force (*F*) between two bodies to the normal force (*N*) pressing these bodies together. **G 40**

3.1.3 *Hertzian contact area*, *n*—the apparent area of contact between two nonconforming solid bodies pressed against each other, as calculated from Hertz' equations of elastic deformation. **G 40**

3.1.4 *Hertzian contact pressure*, *n*—the magnitude of the pressure at any specified location in a Hertzian contact area, as calculated from Hertz' equations of elastic deformation. **G 40**

3.1.5 *lubricant*, *n*—any material interposed between two surfaces that reduces the friction or wear between them. **D 4175**

3.1.6 *lubricating grease*, *n*—a semifluid to solid product of a dispersion of a thickener in a liquid lubricant.

3.1.6.1 *Discussion*—The dispersion of the thickener forms a two-phase system and immobilizes the liquid lubricant by surface tension and other physical forces. Other ingredients are commonly included to impart special properties. **D 217**

[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.G0.04 on Functional Tests Related to Friction, Wear & EP.

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[2] *Annual Book of ASTM Standards*, Vol 05.01.

[3] *Annual Book of ASTM Standards*, Vol 05.02.

[4] *Annual Book of ASTM Standards*, Vol 05.03.

[5] *Annual Book of ASTM Standards*, Vol 03.02.

[6] Available from Beuth Verlag GmbH, Burggrafenstrasse 6, 1000 Berlin 30, Germany.

3.1.7 *thickener*, *n—in lubricating grease*, a substance composed of finely divided particles dispersed in a liquid lubricant to form the product's structure.

3.1.7.1 *Discussion*—The thickener can be fibers (such as various metallic soaps) or plates or spheres (such as certain non-soap thickeners) which are insoluble or, at most, only very slightly soluble in the liquid lubricant. The general requirements are that the solid particles be extremely small, uniformly dispersed, and capable of forming a relatively stable, gel-like structure with the liquid lubricant.

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3.1.8 *wear*, *n*—damage to a solid surface, generally involving progressive loss of material, due to the relative motion between that surface and a contacting substance or substances.

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3.1.9 *Ra*, *n*—in measuring surface finish, the arithmetic average of the absolute distances of all profile points from the mean line for a given distance.[7]

3.1.10 *Rz (DIN)*, *n*—in measuring surface finish, the average of all *Ry* values (peak to valley heights) in the assessment length.[8]

3.1.11 *Ry*, *n*—in measuring surface finish, the vertical distance between the top of the highest peak and the bottom of the deepest valley in one sampling length of the roughness profile.[9]

3.1.12 *SRV*, *n*—Schwingung, Reibung, Verschleiss, (German); oscillating, friction, wear, (English translation).

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3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *seizure*, *n*—localized fusion of metal between the rubbing surfaces of the test pieces.

3.2.1.1 *Discussion*—Seizure is usually indicated by an increase in coefficient of friction, wear, or unusual noise and vibration. In this test method, increase in coefficient of friction is displayed on the chart recorder as rise in the coefficient of friction from a steady state value.

4. Summary of Test Method

4.1 This test method is performed on an SRV test machine using a test ball oscillated under constant load against a test disk.

NOTE 1—The frequency of oscillation, stroke length, test temperature, test load, and test ball and disk material can be varied from those specified in this test method. The test ball yields Hertzian point contact geometry. To obtain line or area contact, test pieces of differing configurations can be substituted for the test ball.

4.2 The wear scar on the test ball and coefficient of friction are measured. If a profilometer is available, a trace of the wear scar on the test disk can also be used to obtain additional wear information.

5. Significance and Use

5.1 This test method can be used to determine wear properties and coefficient of friction of lubricating greases at selected temperatures and loads specified for use in applications where high-speed vibrational or start-stop motions are present for extended periods of time under initial high Hertzian point contact pressures. This test method has found application in qualifying lubricating greases used in constant velocity joints of front-wheel-drive automobiles and for lubricating greases used in roller bearings. Users of this test method should determine whether results correlate with field performance or other applications.

6. Apparatus

6.1 *SRV Test Machine*, [10] illustrated in Fig. 1 and Fig. 2.

6.2 *Microscope*, equipped with a filar eyepiece graduated in 0.01-mm division or equipped with a micrometer stage readable to 0.01 mm. Magnification should be sufficient to allow for ease of measurement. One to 10× magnification has been found acceptable.

7. Reagents and Materials

7.1 *Test Balls*, [10] 52100 steel, 60 ± 2 Rc hardness, 0.025 ± 0.005-µm *Ra* surface finish, 10-mm diameter.

7.2 *Lower Test Disk*, [10] 52100 steel, 60 ± 2 Rc hardness, 0.45 to 0.65-µm *Rz* lapped surface, 24-mm diameter by 7.85 mm thick.

NOTE 2—Test pieces made to 100 Crb steel (DIN 17230) are equivalent.

7.3 *n-Heptane*, reagent grade.

NOTE 3—**Warning:** Flammable. Health hazard.

7.4 *Isopropanol*, reagent grade.

NOTE 4—**Warning:** Flammable. Health hazard.

7.5 *Toluene*, reagent grade.

NOTE 5—**Warning:** Flammable. Health hazard.

7.6 *Cleaning Solvent*, a mixture of equal volumes of *n*-heptane, isopropanol, and toluene.

NOTE 6—**Warning:** Flammable. Health hazard.

8. Preparation of Apparatus

8.1 Turn on the test machine and chart recorder and allow to warm up for 15 min prior to running tests.

8.2 Select the friction data to be presented in the crest peak value position on the test apparatus in accordance with the manufacturer's directions.

NOTE 7—In most cases, this is accomplished by positioning the sliding switch on electronic card No. 291.35.20E (front side of electronics behind the front panel) and the sliding switch located on the back panel of the control unit.

[7] Amstutz, Hu, "Surface Texture: The Parameters," Bulletin MI-TP-003-0785, Sheffield Measurement Division, Warner and Swasey, 1985, p. 21.

[8] Amstutz, Hu, "Surface Texture: The Parameters," Bulletin MI-TP-003-0785, Sheffield Measurement Division, Warner and Swasey, 1985, pp. 31, 29.

[9] Amstutz, Hu, "Surface Texture: The Parameters," Bulletin MI-TP-003-0785, Sheffield Measurement Division, Warner and Swasey, 1985, p. 25.

[10] The sole source of supply of the apparatus known to the committee at this time is Optimol Instruments Prüftechnik GmbH, Friedenstrasse 10, D-81671 Munich, Germany. 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.