Designation: D 6425 – 99

Standard Test Method for Measuring Friction and Wear Properties of Extreme Pressure (EP) Lubricating Oils Using SRV Test Machine[1]

This standard is issued under the fixed designation D 6425; 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 an extreme pressure (EP) lubricating oil's coefficient of friction and its ability to protect against wear when subjected to high-frequency, linear oscillation motion. The procedure is identical to that described in DIN 51834.

1.2 This test method can also be used to determine the ability of a non-EP lubricating oil 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 the 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 4175 Terminology Relating to Petroleum, Petroleum Products, and Lubricants[2]

G 40 Terminology Relating to Wear and Erosion[3]

2.2 *Other Standards:*[4]

DIN 17230 Roller Bearing Steels

DIN 51834, Tribiological Test in the Translatory Oscillation Apparatus (Part 2: Determination of Friction and Wear Data for Lubricating Oils)

3. Terminology

3.1 *Definitions:*

3.1.1 *break-in, n—in tribiology*, an initial transition process occurring in newly established wearing contacts, often accompanied by transients in coefficient of friction or wear rate, or both, that are uncharacteristic of the given tribiological system's long term behavior. (*Synonym:* **run-in, wear-in**) **G 40**

3.1.2 *coefficient of friction μ or f, n—in tribiology*, the dimensionless ratio of the friction force (F_f) between two bodies to the normal force (F_n) pressing these bodies together. **G 40**

$$\mu = (F_f / F_n) \quad (1)$$

3.1.3 *EP lubricating oil, n*—a liquid lubricant containing an extreme pressure (EP) additive

3.1.4 *extreme pressure (EP) additive, n—in a lubricant*, a substance that minimizes damage to metal surfaces in contact under high stress rubbing conditions. **D 4175**

3.1.5 *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**

3.1.6 *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**

3.1.7 *lubricant, n*—any substance interposed between two surfaces for the purpose of reducing the friction or wear between them. **G 40**

3.1.8 *wear, n*—damage to a solid surface, generally involving progressive loss of material, due to relative motion between that surface and a contacting substance or substances. **G 40**

3.1.9 *C.L.A., n*—in measuring surface finish, the arithmetic average of the absolute distances of all profile points from the mean line for a given distance.[5]

3.1.10 *Rz, n*—in measuring surface finish, the average of all *Ry* values (peak to valley heights) in the assessment length.[5]

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.[5]

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *seizure, n*—the stopping of relative motion as the result of interfacial friction.[6]

4. Summary of Test Method

4.1 This test method is performed on an SRV test machine

[1] This test method is under the jurisdiction of ASTM Committee D-2 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.L0.11 on Tribiological Properties of Industrial Fluid Lubricants.

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

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

[4] Available from Deutsches Institut für Normunge, Beuth Verlag GmbH, Burggrafenstrasse6, D-10787 Berlin, Germany.

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

[6] ASM Handbook, "Friction, Lubrication, and Wear Technology," Vol 18, October 1992.

using a test ball oscillated at constant frequency and stroke amplitude and under constant load (F_n), against a test disk that has been moistened with the lubricant specimen. The platform to which the test disk is attached is held at a constant temperature.

NOTE 1—The frequency of oscillation, stroke length, test temperature, test load, test duration, 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 friction force, F_f, is measured by a piezo-electric device in the test disk assembly. Peak values of coefficient of friction, f, are determined and recorded as a function of time.

4.3 After a pre-set test period, the test machine and chart recorder are stopped and the wear scar on the ball is 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 anti-wear properties and coefficient of friction of EP lubricating oils at selected temperatures and loads specified for use in applications in which high-speed vibrational or start-stop motions are present for extended periods of time under initial high Hertzian point contact pressures. It has found application as a screening test for lubricants used in gear or cam/follower systems. Users of this test method should determine whether results correlate with field performance or other applications.

6. Apparatus

6.1 *SRV Test Machine*[7] (see Fig. 1), consists of an oscillation drive, a test chamber (see Fig. 2), and a loading device with a servomotor and a load cell. The machine is operated by a control device for the oscillating drive, a timer, a load control, a frequency control, a stroke control, a data amplifier to determine the friction coefficient, and a switch and a controller for the heating. An oscilloscope may be used for monitoring. Friction coefficients are recorded in relation to time by a chart recorder, or by data acquisition in a computer.

6.1.1 On the firmly mounted receiving block (1) in the test chamber (see Fig. 3), there is a piezoelectric device (2) to measure the friction force, F_f, and the friction coefficient, f; the holder for the test disk (3) with a thermostat-controlled electrical resistance heating element (4); a resistance thermometer (5); the oscillation drive rods (6); an exchangeable holder for the test ball (7); and the load rods of the loading device (8).

6.1.2 The design of the receiving block for the test disk should be such that it has integrated cooling coils, or that cooling coils are wound round it, so that temperatures below ambient are possible. The test disk (9) and the test ball (10) are inserted into their respective holders (3, 4) (see Fig. 3).

6.1.3 Disks are generally used as the lower test piece. Balls, cylinders, rings, or specialized shapes may be used, with appropriate holders, as the upper test piece (see Fig. 4).

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

6.3 *Syringe*, suitable for applying 0.03 mL of the lubricating oil under test.

6.4 *Tweezers*, straight, round, about 200-mm long, with non-marring tips.

6.5 *Torque Wrench*, initial torque 0.5 to 5 nm.

6.6 *Ultrasonic Cleaner*.

7. Reagents and Materials

7.1 *Test Balls*,[7] AISI 52100 Steel, 60 ± 2 HRC hardness, 0.025 ± 0.005-µm C.L.A. surface finish, 10-mm diameter.

7.2 *Test Disk*,[7] AISI 52100 steel, 62 ± 1 HRC hardness, 0.45 to 0.65-µm Rz lapped surface, 24 ± 0.5-mm diameter by 7.8± 0.1-mm thick.

NOTE 2—Test pieces made to 100 Cr 6 roller bearing steel (see 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.

[7] The sole source of supply 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.

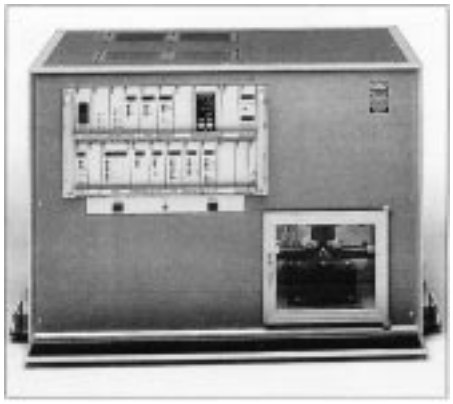

FIG. 1 SRV Test Machine