Designation: D8503 – 23

# Standard Test Method for Determining the Scuffing Temperature Limit of Lubricating Oils Using the SRV Test Machine[1]

This standard is issued under the fixed designation D8503; 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 the determination of a scuffing temperature limit of lubricating oils at prescribed conditions and the retention of friction over temperature load step increases in a roller-on-disk (flat) geometry when subjected to high-frequency, linear oscillation motion. This test method is executed under constant load, frequency and stroke in a SRV test machine. The evolution of coefficient of friction of lubricating oils as function of temperature is recorded and assessed.

1.2 Tribometrical scuffing tests were so far related to load step tests. This test method determines the upper temperature limit for operating a lubricant and can also be used to determine the ability of a non-EP lubricating oil to protect against scuffing with increasing temperature.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

A295 Specification for High-Carbon Anti-Friction Bearing Steel

D235 Specification for Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent)

D4175 Terminology Relating to Petroleum Products, Liquid Fuels, and Lubricants

D5706 Test Method for Determining Extreme Pressure Properties of Lubricating Greases Using a High-Frequency, Linear-Oscillation (SRV) Test Machine

D6425 Test Method for Measuring Friction and Wear Properties of Extreme Pressure (EP) Lubricating Oils Using SRV Test Machine

D7755 Practice for Determining the Wear Volume on Standard Test Pieces Used by High-Frequency, Linear-Oscillation (SRV) Test Machine

E45 Test Methods for Determining the Inclusion Content of Steel

G40 Terminology Relating to Wear and Erosion

2.2 *DIN Standards:*[3]

DIN 5402–1 Rolling bearings – Parts of rolling bearings – Part 1: Cylindrical rollers

DIN 51631:1999 Mineral spirits; special boiling point spirits; requirements

DIN 51834 Tribological Test in the Translatory Oscillation Apparatus (Part 4: Determination of friction and wear data for lubricating oils with the cylindrical roller-disk geometry)

## 3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this test method, refer to Terminologies D4175 and G40.

3.1.2 *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, that are uncharacteristic of the given tribological system's long-term behavior. (*Synonym*: **run-in**, **wear-in**)

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

[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.L0 on Industrial Lubricants and Engineering Sciences of High Performance Fluids and Solids.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from Deutsches Institut für Normung e.V. (DIN), Am DIN-Platz, Burggrafenstrasse 6, 10787 Berlin, Germany, http://www.din.de.

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

3.1.4 *extreme pressure (EP) lubricants, n*—formulations whose effects may become observable at different operating conditions, preventing adhesive wear under mixed or boundary lubrication regimes and are characterized by an in crea sed load carrying capacity or increased tribofilm strength.

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.

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

3.1.6.1 *Discussion*— The Hertzian contact pressure can also be calculated and reported as maximum value $P_{max}$ in the centre of the contact or as $P_{average}$ as average over the total contact area.

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

3.1.8 $P_{geom}$—geometric contact pressure describes the load carrying capacity at test end.

3.1.9 *Ra (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.[4]

3.1.10 *Rz (DIN), n*—in measuring surface finish, the average of all *Ry* values (peak to valley heights) in the assessment length.[4]

3.1.11 *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.

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. D5706

3.2.1.1 *Discussion*—In this test method, seizure is indicated by a sharp rise in the coefficient of friction, over steady state, of greater than 0.2 for over 20 s. In severe cases, a stoppage in the motor will occur. Different spontaneous and short manifestations of the friction force curve need not necessarily be indicative of adhesive wear mechanisms. The evolution of the friction signal can be coupled with the stroke as an additional indicators.[5] In such a case and independently from the evolution of the friction signal, the assessment of the signals may be validated as follows: (*1*) Unstable and ragged signal: if $\Delta x < \pm 10$ % of stroke, likely no adhesive wear mechanism. (*2*) Strong fluctuations: if $\Delta x > \pm 10$ % of stroke in combination with homologue friction signals, adhesive mechanisms are likely. (*3*) jump or sharp rise in friction level: if Δcof increases by > ±10 % after sharp peaks either in the fricition and/or stroke signal, adhesive mechanisms are likely, which have damaged the surfaces resulting in higher friction. The reaction layer was pierced resulting in metal-to-metal contact or the ball turned in the holder.

3.3 *Abbreviations:*

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

## 4. Summary of Test Method

4.1 This test method is performed on a SRV test machine using a test roller oscillated at constant frequency and stroke amplitude and under constant load ($F_n$), against a test disk that has been wetted with the lubricant specimen, where the temperature is increased stepwise. The movement of the longitudinal roller axis is 90° to the sliding direction (see Fig. 1). The test disk receiving block to which the test disk is attached is stepwise heated to the preset temperature.

NOTE 1—The frequency of oscillation, stroke length, test temperature, test load, test duration, and test roller and disk material can be varied from those specified in this test method. The test roller yields Hertzian line contact geometry.

4.2 The friction force, $F_f$, is measured by a piezo-electric device mounted in the test disk assembly. Peak values of coefficient of friction, *f*, are determined and recorded as a function of time with the associated with temperature.

## 5. Significance and Use

5.1 This test method can be used to determine scuffing temperature limit and the evolution of coefficient of friction of lubricating oils with increasing temperatures for use in tribological contacts in which high-speed vibrational or start-stop motions are present for extended periods of time under initial high Hertzian line contact pressures. It has found application as a screening test for engine oils, gear lubricants and turbine oils. The test temperature may reach up to 300 °C. Users of this test method should determine whether results correlate with field performance or other applications. In comparison to the ball-on-disk geometry in accordance with Test Method D6425, the initial contact pressure is better retained over test time in this roller-on-disk geometry.

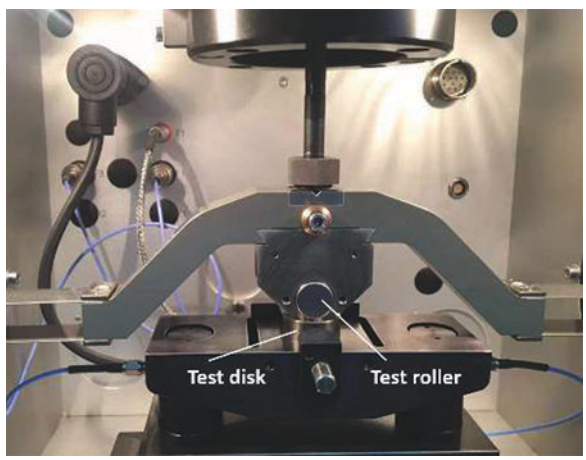


**FIG. 1 Test Chamber with Roller and Disk Specimen**

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

[5] Woydt, M. and G. Patzer, "New methodologies indicating adhesive wear in load step tests on the translatory oscillation tribometer," *LUBRICANTS*2021, Vol. 9, Issue 10, 101, https://doi.org/10.3390/lubricants9100101.