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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Test Method for COEFFICIENT OF FRICTION AND WEAR OF SINTERED METAL FRICTION MATERIALS UNDER DRY-CLUTCH CONDITIONS[1]

This standard is issued under the fixed designation B 526; 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.

[ε1] NOTE—Section 8 was added editorially in August 1985.

1. Scope

1.1 This test method covers the determination of the static and dynamic coefficients of friction and the wear rate of sintered metal friction materials under dry-clutch conditions by subjecting an annular test specimen to repeated inertia stops under a single set of conditions. The test conditions of speed, pressure, energy, and operating temperature are generally representative of the operating conditions of dry-clutch facings in moderate duty applications. The values derived from this test method are suitable for rating materials within the general area of applicability and, as such, may be used for initial design consideration or quality control purposes, but are not suitable for final design criteria unless field correlation has been established. Where close correlation of results is required, identical test fixtures should be used to preclude differences which may result from various clutch designs. Design variations, that could result in differences and that are not listed as parameters in this test method, include (*1*) weight ratio of opposing members to friction member, (*2*) ratio of swept area to total area, (*3*) friction carrier hub design, and (*4*) friction carrier plate design.

1.2 The values stated in inch-pound units are to be regarded as the standard. The SI equivalents are in parentheses and may be approximate.

1.3 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Applicable Documents

2.1 *ASTM Standards:*

A 159 Specification for Automotive Gray Iron Castings[2]

3. Apparatus

3.1 *General*—The test machine shall be an inertia dynamometer in which the test fixture is located between a stationary torque reaction section and a rotating flywheel section. Means shall be provided to accelerate the inertia flywheel and permit it to coast at the specified speed. The torque section shall be provided with a means for measuring the torque reaction from the output of the test fixture.

3.2 *Test Fixture*—The test fixture shall be a clutch mechanism with one or more pairs of rubbing surfaces and a means of engaging the rubbing surfaces at the specified applied pressure. A pair of rubbing surfaces shall consist of a test specimen and a opposing member, one of which shall be connected to the rotating flywheel shaft and the other to the stationary torque reaction shaft. The clutch-engaging device shall be capable

[1] This test method is under the jurisdiction of ASTM Committee B-9 on Metal Powders and Metal Powder Products and is the direct responsibility of Subcommittee B09.07 on Friction Materials.

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[2] *Annual Book of ASTM Standards*, Vol 01.02.

of applying full clutch load in less than 0.2 s.

3.3 *Instrumentation and Control*—Means shall be provided to determine flywheel speed, clutch-output torque, clutch apply load, friction-facing soak temperature, and clutch stop time. Friction-facing soak temperature shall be determined by means of a thermocouple located in the friction material as far behind the rubbing surface as possible and in the center of the wear track. Clutch-output torque shall be recorded as a function of time.

4. Test Specimen

4.1 The test specimen shall be an annular ring facing with an outside diameter of 10 in. (250 mm) or less, an inside diameter of 6 in. (150 mm) or more, and an over-all thickness of approximately 0.150 in. (3.8 mm). It shall be composed of a sintered metal friction material composition bonded to a steel backing member having a thickness of approximately 0.060 in. (1.5 mm). The rubbing surface shall contain 6 or 8 equally spaced radial grooves, ⅛-in. (3.2-mm) wide by 1/16-in. (1.6-mm) deep. The test specimen shall be mounted to a carrier by means of 8 to 12 steel rivets with a nominal size of approximately 3/16 in. (4.8 mm). The test specimen shall be ground after mounting to the carrier to obtain parallelism within 0.002 in. (0.05 mm).

4.2 *Opposing Member*—The opposing member shall be a gray cast iron Alloy No. 113 in accordance with Specification A 159. The surface should be ground prior to the test to a 40 to 60 μin. (1.0 to 1.5 μm) finish.

5. Procedure

5.1 Select facing area, flywheel inertia, flywheel speed, and clutch apply load to establish the following test conditions:

Unit energy	300 ft·lbf/in.^{2} (630 kJ/m^2)
Surface speed at mean radius at engagement	2200 ± 300 fpm (11 ± 2 m/s)
Unit facing pressure	40 psi (276 kPa)

5.2 Measure thickness of test specimen and opposing member at three selected positions on each surface.

5.3 Make 2000 stops at the conditions in 5.1 controlling the frequency of stops to maintain a cluch-facing temperature at the time of engagement of 350 to 400°F (177 to 204°C).

5.4 Measure dynamic and static coefficients of friction every 200 stops at operating temperature.

5.4.1 *Dynamic Coefficient of Friction*—Determine from either the stop time or the average torque by the following equations:

$$\mu = T/FRN, \text{ or } \mu = Iw/FRN\,t$$

where:

μ = average dynamic coefficient of friction,
F = effective load, lbf (N),
R = mean radius, ft (m),
N = number of rubbing surface pairs,
T = average torque, ft·lbf (N·m),
I = flywheel inertia, lbf·ft·s^2 (N·m·s^2),
w = engaging speed, rad/s, and
t = stop time, s.

5.4.2 *Static Coefficient of Friction*—Determine from breakaway torque at operating temperature as follows:

$$\mu_s = T_s/FRN$$

where:

μ_s = static coefficient of friction, and
T_s = breakaway torque, ft·lbf (N·m)

5.5 Measure the thickness as in 5.2 at the same locations.

6. Report

6.1 The following information shall be reported for each test (see Fig. 1):

6.1.1 *Test Specimen Data*—Friction material designation, outside and inside diameter, nominal facing thickness, number and size of radial grooves, number and size of rivet hole counterbores, gross and actual area, and number of faces.

6.1.2 *Flywheel Data*—Moment of inertia, rotational speed at engagement, and total energy.

6.1.3 *Clutch Load Data*—Total apply load, return spring force, clutch apply time, and method of application.

6.1.4 *Test Condition*—Unit energy, surface speed, and unit facing pressure.

6.1.5 *Dynamic Coefficient of Friction.*

6.1.6 *Static Coefficient of Friction.*

6.1.7 *Test Specimen Wear.*

6.1.8 *Opposing Member Wear.*

6.1.9 *Typical Torque Curves.*

7. Calculation

7.1 *Unit Energy:*

$$\text{ft·lbf/in.}^2\ (\text{J/m}^2) = \frac{\text{Total Energy, ft·lbf (J)}}{\text{Gross Area/Face, in.}^2\ (\text{m}^2) \times \text{No. of Faces}}$$