



Designation: G 83 – 96

Standard Test Method for Wear Testing with a Crossed-Cylinder Apparatus¹

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1. Scope

1.1 This test method covers a laboratory test for ranking metallic couples in their resistance to sliding wear using the crossed-cylinder apparatus. During the test, wear occurs at a contact between a rotating cylinder and a stationary cylinder which have their long axes oriented normal to each other.

1.2 When the rotating and stationary cylinders are of the same material, wear test results are reported as the total volume loss in cubic millimetres for the rotating and stationary cylinders. The manner of recording the results also specifies the particular test procedure used. The value is obtained by adding the volume loss of the rotating member to the volume loss of the nonrotating member. Materials of higher wear resistance will have lower volume loss.

NOTE 1—To attain uniformity among laboratories, it is the intent of this test method to require that volume loss due to wear be reported only in the metric system as cubic millimetres ($1 \text{ mm}^3 = 6.102 \times 10^{-5} \text{ in.}^3$).

1.3 When dissimilar materials are being tested, wear test results are reported as the total volume loss in cubic millimetres for the rotating and stationary test cylinders as well as the volume loss of each cylinder separately. When two different metals or alloys are tested, it is also recommended that each metal or alloy be tested in both the stationary and moving positions. Then, for each metal or alloy, the combined volume of wear in both positions should be used in comparisons with self-mated wear volume.

1.4 The test method describes three recommended procedures that are appropriate for different degrees of wear resistance.

NOTE 2—The crossed-cylinder wear test inherently exhibits a time varying contact area. A plot of wear volume versus sliding distance is typically nonlinear. Therefore, results obtained using parameters other than those specified in the test method cannot be used to calculate an expected value.

1.4.1 *Procedure A*—This is a relatively severe test that will rank metallic materials which have high-wear resistance.

¹ This test method is under the jurisdiction of ASTM Committee G-2 on Wear and Erosion and is the direct responsibility of Subcommittee G02.40 on Non-Abrasive Wear.

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Materials with wear resistance in the high-speed tool steel category are particularly suited to this test.

1.4.2 *Procedure B*—This is a short-term variation of Procedure A.

1.4.3 *Procedure C*—This is a lower speed and shorter term variation of Procedure A that is particularly useful in ranking materials of low-wear resistance.

1.5 In reporting, the values stated in SI units are preferred.

1.6 *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:

E 122 Practice for Choice of Sample Size to Estimate a Measure of Quality for a Lot or Process²

E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods²

G 40 Terminology Relating to Wear and Erosion³

3. Terminology

3.1 Definitions used in this test method are defined in accordance with Terminology G 40 as follows:

3.1.1 *coefficient of friction or f in tribology*—the dimensionless ratio of the friction force (F) between two bodies to the normal force (N) pressing these bodies together

$$\mu = (F/N)$$

3.1.2 *debris*—in tribology, particles that have become detached in a wear or erosion process.

3.1.3 *lubricant*—any substance interposed between two surfaces for the purpose of reducing the friction or wear between them.

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

3.1.5 *wear rate*—the rate of material removal or dimensional change due to wear per unit of exposure parameter for

² Annual Book of ASTM Standards, Vol 14.02.

³ Annual Book of ASTM Standards, Vol 03.02.

example, quantity of material removed (mass, volume, thickness) in unit distance of sliding or unit time.

3.1.5.1 *Discussion*—Because of the possibility of confusion, the manner of computing wear rate should always be carefully specified.

the weight loss to volume loss in cubic millimetres. Wear measurements are reported as volume loss per specified procedure.

5. Significance and Use

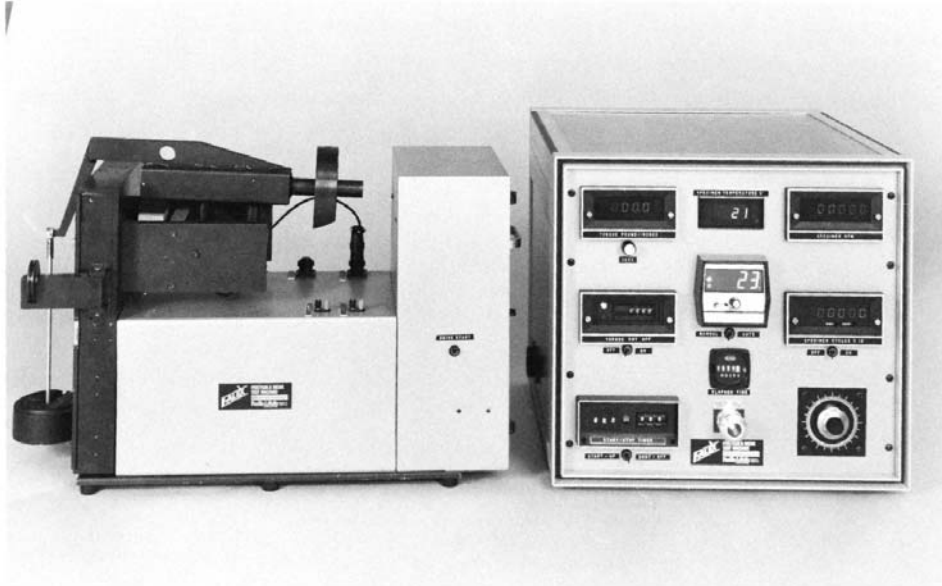


FIG. 1 Falex Crossed Cylinders Test Machine

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *applied load*—the dead-weight load placed on the crossed-cylinders.

3.2.1.1 *Discussion*—The weight of the stationary specimen holder is included.

3.2.2 *crossed-cylinder apparatus*—machine capable of testing two cylindrical specimens, positioned perpendicular to each other under load, one rotating at a specified speed while the other is stationary.

3.2.3 *sliding distance*—the distance computed, as the product of the circumference of the unworn cylinder and the number of revolutions.

3.2.4 *sliding speed*—the test speed of the rotating specimen.

3.2.5 *wear track*—the visual surface damage due to relative motion between the crossed cylinder specimens.

4. Summary of Test Method

4.1 For the crossed-cylinder wear test, two cylindrical specimens are positioned perpendicular to each other. The test machine should allow one specimen to rotate at speeds up to 400 r/min. The second, nonrotating specimen is pressed against the rotating specimens at a specified load by means of an arm and attached weights. It is the intent of the apparatus design that dead-weight loading be used. The test duration and rotational speed are varied as noted in Procedures A through C (see Section 8).

4.2 The amount of wear is determined by weighing the specimens before and after the test. Because of the wide differences in the density of materials, it is necessary to convert

5.1 The amount of wear in any system will, in general, depend upon a number of factors such as the applied load, sliding speed, the sliding distance, environment as well as the material properties. In this test method, these conditions are standardized to provide a means of determining the relative wear rates of different metal couples. The value of the test method lies in predicting the relative ranking of various materials where metal-to-metal contact takes place. Since the test method does not attempt to duplicate all the conditions that may be experienced in service (for example, lubricant, load, removal of wear debris, and presence of corrosive environment), there is no assurance that the test will predict the relative wear rate of a given material under conditions differing from those in the test.

6. Apparatus

6.1 *General Description*—Fig. 1 shows a commercially available design of this test equipment. This type of machine will typically consist of a belt-driven spindle, a chuck or collet device for holding the rotating specimen, a lever-arm device to hold the nonrotating specimen and attachments to allow the nonrotating specimen to be forced against the rotating specimen with a controlled load. The commercially available unit has an optional friction force measuring system that allows coefficient of friction to be calculated.^{4,5}

⁴ Original users of this test method designed and fabricated their own test machines.