Designation: D 3028 – 95

An American National Standard

# Standard Test Method for Kinetic Coefficient of Friction of Plastic Solids[1]

This standard is issued under the fixed designation D 3028; 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 sliding (kinetic) friction of plastic solids or sheeting (as moving specimens) when sliding against similar or dissimilar substances (Note 1) (as fixed specimens) through the speed range of approximately 0.10 to 3.00 m/s. The instrument used is a variable speed, variable normal-force frictionometer.[2, 3]

NOTE 1—The physical form for these fixed specimens should be that of rigid or self-supporting solids. Attempts to mount thin sheeting, film, foil, etc., are not recommended due to the difficulty encountered when attempting to meet the weight and concentricity requirements (see 4.1.1).

1.2 Rigid or self-supporting specimens must be machined to specified dimensions. Normally, sheeting exceeding 1.00 mm (0.040 in.) in thickness should not be tested on a mounting wheel of standard diameter.

NOTE 2—An error accumulation of 1 % per 0.50 mm (0.020 in.) of sheeting thickness results as the standard diameter of the test surface is increased. If the resulting error is not tolerable, undersize mounting wheels can be employed.

1.3 Two testing procedures are included. Selection of a procedure is determined by the specific interests of the investigator. The procedures are:

1.3.1 *Procedure A*—Determination of variable-velocity kinetic coefficients, and

1.3.2 *Procedure B*—Determination of constant-velocity kinetic coefficients over an extended period of time.

1.4 Test data obtained by this test method is relevant and appropriate for use in engineering design.

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

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:*

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing[4]

D 4000 Classification System for Specifying Plastic Materials[5]

## 3. Significance and Use

3.1 Kinetic coefficients of friction serve as indexes for characterizing materials that are subjected to conditions of slip. Many variables affect the frictional behavior of materials and by offering more than a single method of test the influence of these variables can be more readily observed.

3.2 The specific procedures offer investigators an opportunity to select a method of testing that is best suited to their particular interests. Diversified applications of frictional information can thus be served and a closer correlation between test results and actual performance might be expected.

3.3 Procedure A provides data with respect to many different velocities within a specified range. Effects of wear and temperature are kept to a minimum. Although these effects are minimized, their influence is often recognized when the values obtained while descending the velocity scale (see 8.1) consistently differ with those obtained while ascending the velocity scale.

3.4 Procedure B provides data with respect to wear and temperature. Effects of changing velocities are eliminated since the testing velocity is held constant.

3.5 Since frictional properties often depend on surface conditions, it should not necessarily be expected that identical results between like specimens will always occur. Surface properties of materials under study can vary greatly when they are produced by different processes or by like processes on different equipment. In the case of film testing, the time-dependent blooming of lubricants or other processing additives can produce varying surface conditions.

3.6 For many materials, there may be a specification that requires the use of this test method, but with some procedural

[1] This test method is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.10 on Mechanical Properties.

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[2] Available from Custom Scientific Instruments Inc., Whippany, NJ.

[3] Westover, R. F., and Vroom, W. I., "A Variable Speed Frictionometer for Plastics, Rubbers, Metals, and other Materials," *S.P.E. Journal*, Vol 19, No. 10, October 1963.

[4] *Annual Book of ASTM Standards*, Vol 08.01.

[5] *Annual Book of ASTM Standards*, Vol 08.02.

modifications that take precedence when adhering to the specification. Therefore, it is advisable to refer to that material specification before using this test method. Table 1 of Classification System D 4000 lists the ASTM materials standards that currently exist.

## 4. Apparatus

4.1 *Specimen Preparation Apparatus*:

4.1.1 *Lathe*, suitable for the machining of the rigid specimens to the required dimensions.

4.1.2 *Scissors or Cutter*, suitable for cutting film or sheeting specimens to the required dimensions.

4.2 *Specimen Testing Apparatus*:

4.2.1 *Variable Speed, Variable Normal-Force Frictionometer*, with necessary calibration weights and tachometer, suitable for measuring the peripheral velocity of the moving specimen to 3.00 m (120 in.)/s.

4.2.1.1 The principle of the frictionometer's operation is shown in Fig. 1*a*. A rotational velocity is imparted to the 100-mm diameter specimen and the tangential velocity of its test surface is measured with a suitably modified tachometer. The fixed friction member is attached through a counterbalanced pivot arm to a pendulum that is free to rotate about the same axis as does the rotating friction member. The pivot point for the pivot arm lies on a tangent to the rotating specimen at the point of friction contact so that the friction force has no feedback effect upon the normal force which is applied by an encased spring located behind the adjusting knob (Fig. 1*b*). The center of gravity of the pivot arm system is located at the pivot point so that the pendulum attitude will have no effect upon the normal force (see X3.1).

4.2.1.2 The friction force, *F*, where $F = \mu n$ with μ being the coefficient of friction, and, *n* being the normal force, acting at a radius of 50.0 mm, produces the moment that rotates the pendulum about its axis. The resisting moment is the weight of the entire pendulum system times the horizontal distance between the axis of rotation and the center of gravity of the entire pendulum system (see Fig. 1*a* and Appendix X1).

4.2.1.3 For a given pendulum moment and given normal force, the sine of the angle of pendulum rotation varies with the coefficient of friction. For this reason the scale on the instrument is calibrated to read the sine of the angle directly up to the maximum angle of 45°.

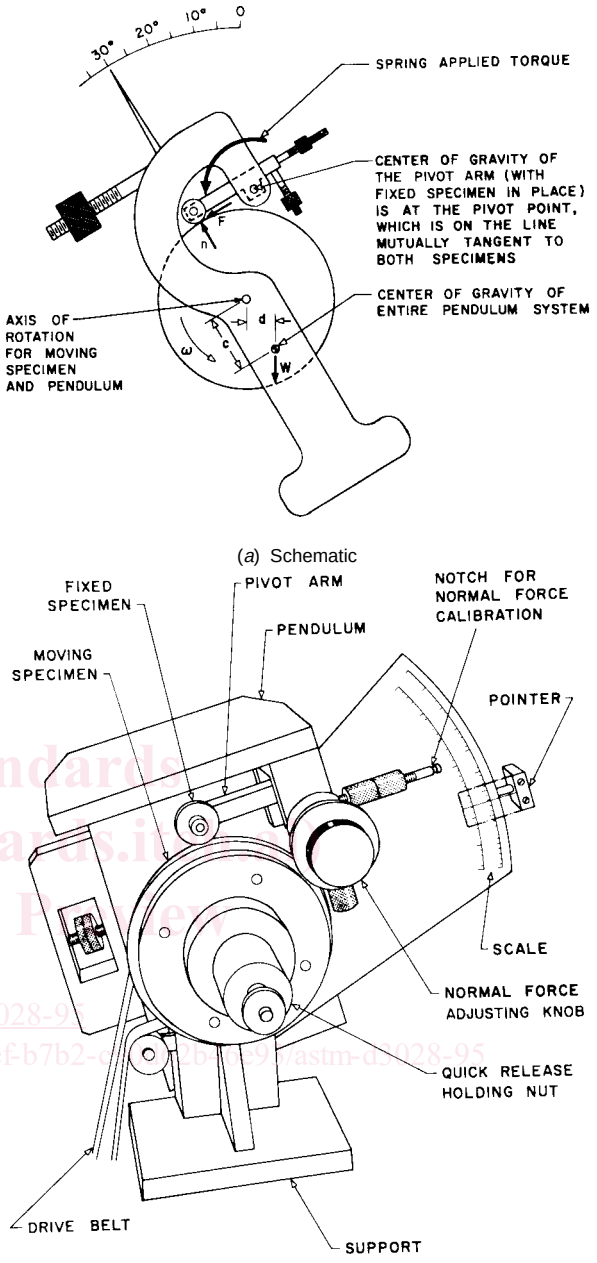


**FIG. 1 Frictionometer Components**

## 5. Test Specimens

5.1 Three distinct types of specimens may be used:

5.1.1 *Rigid (self-supporting) Fixed Specimens*, of 20.0 ± 0.1 mm (0.788 ± 0.004 in.) diameter by 2.0 ± 0.1 mm (0.079 ± 0.004 in.) thick with a concentric mounting hole of minimum clearance, must have a mass of 5.00 ± 0.01 g (Fig. 2*a*). This requirement is dictated by the design of the testing apparatus. If the mass of the specimen itself is less than 5.00 ± 0.01 g, the difference in mass can be made up by the addition of a suitable washer that has been carefully machined to complement the mass of the specimen. Both specimen and washer should fit snugly to the mounting screw and have their respective centers of gravity on the centerline of this screw.

5.1.2 *Rigid (self-supporting) Moving Specimens*, having a 100.0 ± 0.1-mm (3.937 ± 0.004-in.) diameter with a concentric mounting hole that will fit snugly to the hub of the mounting wheel (Fig. 2*b*). The minimum thickness of these specimens shall be that which ensures the full 2.0-mm (0.079-in.) line contact between specimens (the fixed specimen's thickness). Usually a thickness of 2.54 to 3.18 mm (0.100 to 0.125 in.) is adequate when the materials are sufficiently rigid. The test surface of these specimens (that produced by the last or finish cut when machined) shall be produced with a sharp round-nose cutting tool of approximately 1.6-mm (0.06-in.) radius. No attempt shall be made to polish or, in any other way impart to the test surface of these specimens, a finish other than that produced by the tool during the finish cut.

5.1.3 Film or sheeting that is to serve as a moving specimen shall be cut into strips, approximately 12.5-mm (0.50-in.) wide