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An American National Standard

Standard Test Method for Coefficient of Static and Kinetic Friction of Uncoated Writing and Printing Paper by Use of the Horizontal Plane Method[1]

This standard is issued under the fixed designation D4917; 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.

ε[1] NOTE—The research report number in footnote 5 was editorially corrected in November 2008.

1. Scope

1.1 This test method describes a horizontal plane procedure for the determination of the coefficient of static and kinetic friction of paper measured when sliding against itself.

1.2 Although this test method is basic in concept, the precision statement has been developed on uncoated writing and printing papers. While the use of this test method is recommended for those grades only, it may be used with other types of papers giving specific attention to special paper characteristics and with the understanding that the precision and bias may not be the same.

1.3 The horizontal instrument requires some means of movement of the specimen in relation to the surface upon which it rests. The coefficient of friction (COF) is measured directly from the resistance to tangential motion and the applied weight pressing two pieces of paper together.

1.4 Static COF relates to the force required to initiate movement between two surfaces while kinetic COF relates to the force required to cause continuation of the movement at uniform speed.

1.5 An inclined plane method is described in Test Method D4918, which gives similar results for static COF but Test Method D4918 cannot be used for the determination of kinetic COF. The choice of approach depends on the equipment available and the means of measurement.

1.6 The determination of this characteristic for corrugated and solid fiberboard is described in Test Methods D4521 and D3247. These test methods differ in that in Test Methods D4521 and D3247, the two specimens are allowed to slip upon one another three times before the force measurement is determined, while in this test method the determination is made on the first slip.

1.7 *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:*[2]

D528 Test Method for Machine Direction of Paper and Paperboard

D585 Practice for Sampling and Accepting a Single Lot of Paper, Paperboard, Fiberboard, and Related Product

D685 Practice for Conditioning Paper and Paper Products for Testing [3]

D725 Discontinued 1980; Method for Identification of Wire Side of Paper; Reinstated 1990 as D 5039[3]

D828 Test Method for Tensile Properties of Paper and Paperboard Using Constant-Rate-of-Elongation Apparatus[3]

D1968 Terminology Relating to Paper and Paper Products

D3247 Method of Test for Coefficient of Static Friction of Corrugated and Solid Fiberboard (Horizontal Plane Method)[3]

D3460 Specification for White Watermarked and Unwatermarked Bond, Reprographic, and Laser Printer Cut-Sized Office Papers [3]

D4521 Test Method for Coefficient of Static Friction of Corrugated and Solid Fiberboard (Discontinued 2001)[3]

D4918 Test Method for Coefficient of Static Friction of Uncoated Writing and Printing Paper by Use of the Inclined Plane Method

[1] This test method is under the jurisdiction of ASTM Committee D06 on Paper and Paper Products and is the direct responsibility of Subcommittee D06.92 on Standard Documents Relating to Paper and Paper Products.

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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] Withdrawn.

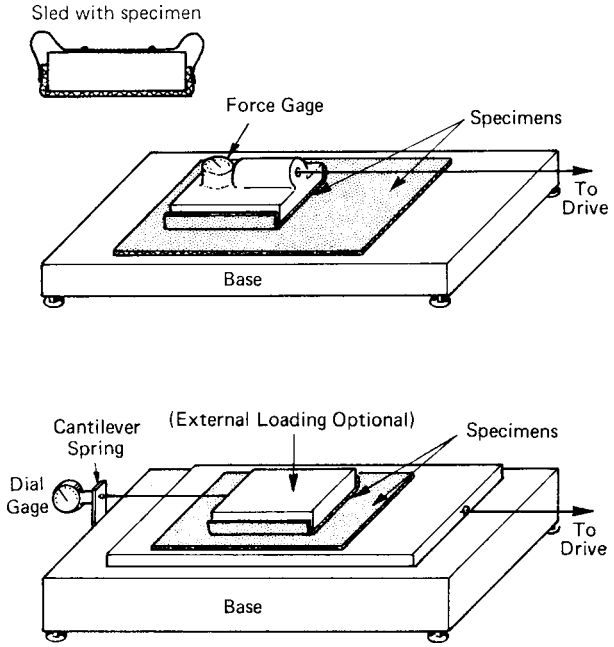

FIG. 1 Schematics for Two Horizontal Plane Instruments

E122 Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process

3. Terminology

3.1 *Definitions*—Definitions shall be in accordance with Terminology D1968 and the *Dictionary of Paper.*[4]

4. Summary of Test Method

4.1 One specimen of the paper sample is clamped to a horizontal plane surface, the other to a specimen sled. The sled is pulled across the surface, or alternatively, the plane is pulled under the stationary sled by mechanical means, and the force required to do so is measured. The coefficients of both static and kinetic friction can be determined.

5. Significance and Use

5.1 The coefficient of friction of printing and writing papers is an indicator of the ease with which the top or bottom sheet of a stack of paper will slide across the succeeding sheet, such as occurs on the infeed of a printing press or the sheet transport into a copier machine. A minimum coefficient of friction is required to prevent double-feeding of any sheets.

5.2 Since each sheet is removed from the stack only once, a single slide of each pair of specimens is performed and the value recorded.

6. Apparatus (see Fig. 1)

6.1 *Horizontal Plane and Supporting Base*—A horizontal plane surface of a smooth, incompressible material—metal, hardwood, plate glass, or plastic—having a width at least 25 mm (1 in.) wider than the specimen sled (see 6.2). The plane is mounted on a supporting base provided with means of leveling in two directions. A constant rate-of-motion tester, as described in Test Method D828, has also been found suitable. If this type of tester is used, the horizontal plane and supporting base are one and the same.

6.2 *Specimen Sled*—A sled or specimen block made of an incompressible material with a rubber-faced lower surface or such material with a COF significantly higher than the material being tested. A 63.5-mm (2.5-in.) square metal block weighing 200 ± 5 g has been found satisfactory. A means for clamping the specimen to the sled may be provided, but is not necessary if the lower surface is faced with 3-mm (⅛-in.) thick soft rubber. A means for fastening the sled to the force measuring device, such as a wire cable or nylon filament line, is required. Care should be taken in selecting a wire cable or nylon filament line to make certain that its ability to stretch does not interfere with the measurement of force.

6.3 *Mechanical Power Unit*—Providing a means for moving the specimen sled horizontally along the plane surface, or the plane surface under the specimen sled at a uniform speed of 150 ± 30 mm/min (0.5 ± 0.1 ft/min). A constant rate-of-motion tester equipped with a load cell in its upper crosshead and a constant rate-of-motion lower crosshead has been found satisfactory (Test Method D828).

6.4 *Force Measuring Device*—Means for measuring the force required to move or restrain the specimen sled to the nearest 5 gf (0.01 lbf). A force gage or the load cell of a constant rate-of-motion tester have both been found suitable (Test Method D828).

6.5 *Paper Cutter*, to cut test specimens.

7. Sampling and Test Specimen Preparation

7.1 For acceptance sampling, obtain the sample in accordance with Practice D585.

7.2 When sampling for other purposes, use Practice E122 as an alternative.

7.3 The sample, selected in accordance with Practice D585 should be in the form of a finished ream or a "lift" sample from a roll. A lift is a stack of sheets about 1.3 cm (0.5 in.) cut from a roll.

7.4 Precondition, condition, and test in the atmospheres described in Practice D685.

7.5 Cut the sample into test specimen pairs as follows:

7.5.1 *Finished Ream Sample*:

7.5.1.1 *With Machine Direction COF*—Lift off a stack of six consecutive sheets, identify the machine direction (Test Method D528) and the felt (or top) side (Method D725) of the top sheet, and cut two specimens from each sheet: one 100 by 215 mm (4 by 8.5 in.) and the other 75 by 130 mm (3 by 5 in.). Cut the specimens so that the machine direction is parallel to the long dimension. Stack the two sets of specimens in separate piles, maintaining the same order of sheets as in the ream. Take the top sheet off the pile of larger specimens and discard. Use the second large specimen with the first small specimen, the third large specimen with the second specimen, and so on, performing the test with five pairs of specimens from consecutive sheets. There will be one left-over small specimen (sixth) which can be discarded.

[4] Available from Technical Association of the Pulp and Paper Industry (TAPPI), 15 Technology Parkway South, Norcross, GA 30092, http://www.tappi.org.