Designation: D3108/D3108M – 13 (Reapproved 2020)

Standard Test Method for Coefficient of Friction, Yarn to Solid Material[1]

This standard is issued under the fixed designation D3108/D3108M; 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 measurement of the kinetic frictional properties of a moving yarn in contact with a solid material.

NOTE 1—For determining yarn-to-yarn friction, refer to Test Method D3412.

1.2 This test method specifies a relative speed of 100 m/min. The test method may be used at other speeds, although with a possible change in precision and coefficient of friction.

1.3 This test method covers the measurement of the coefficient of kinetic friction between yarn and solid surface or surfaces of constant radius in the contact area. If a yarn of uniform value is used, comparisons of frictional properties of different solid materials can be made with relation to that yarn. If a given solid material is used, comparisons of frictional properties of different yarns, or yarns with different finishes, can be made with relation to that particular solid material.

1.4 This test method specifically recommends wrap angles of 1.57, 3.14 and 6.28 radian (90, 180 and 360°), but other wrap angles may be used, again with a possible change in precision and level. The angle of wrap should not be so great, especially for yarns having high coefficients of friction, that it causes the output tension to exceed the yield value for the yarn being tested. Also, in every case the angle of wrap should not be less than 1.57 rad (90°).

1.5 This test method has been applied to yarns having linear densities ranging between 1.5 and 400 tex [14 and 3600 denier] and having coefficients of friction ranging between 0.1 and 1.0 but may also be used with yarns outside these ranges of linear densities and coefficients of friction.

1.6 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*Specific precautionary statements are given in Section 7.

1.8 *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]

D123 Terminology Relating to Textiles
D1776 Practice for Conditioning and Testing Textiles
D1907 Test Method for Linear Density of Yarn (Yarn Number) by the Skein Method
D2258 Practice for Sampling Yarn for Testing
D3412 Test Method for Coefficient of Friction, Yarn to Yarn
D4849 Terminology Related to Yarns and Fibers

3. Terminology

3.1 For all terminology relating to D13.58, Yarns and Fibers, refer to Terminology D4849.

3.1.1 The following terms are relevant to this standard: coefficient of friction, friction, kinetic friction, radian, static fraction, wrap angle.

3.2 For all other terminology related to textiles, refer to Terminology D123.

4. Summary of Test Method

4.1 A length of yarn is run at known speeds and in contact with either single or multiple friction surfaces using a specified wrap angle. (See Fig. 1.) The yarn input and output tensions are measured, and the coefficient of friction is calculated by means of Amontons' law (see 11.4). Alternatively, apparatus is used in

[1] This test method is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.58 on Yarns and Fibers.

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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.

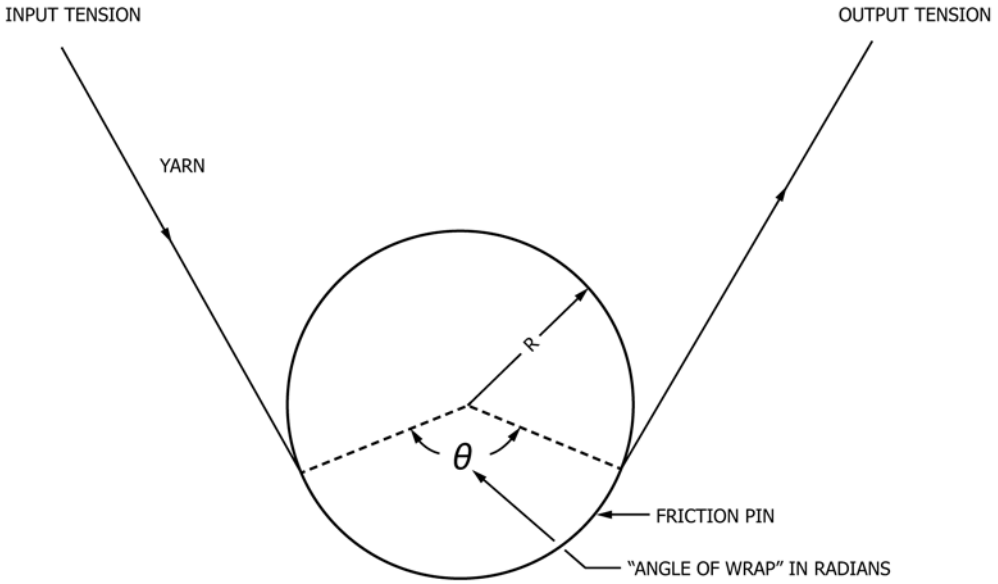

FIG. 1 Schematic Diagram of Angle of Wrap

which the ratio of output tension to input tension is measured allowing the coefficient of friction to be indicated directly.

5. Significance and Use

5.1 Test Method D3108 for the determination of kinetic friction between yarn and solid materials may be used for the acceptance testing of commercial shipments of yarn, but caution is advised since between laboratory precision is known to be poor. Comparative tests as directed in 5.1.1 may be advisable.

5.1.1 If there are differences or practical significance between reported test results for two laboratories (or more), comparative tests should be performed to determine if there is a statistical bias between them, using competent statistical assistance. As a minimum, test samples that are as homogenous as possible, drawn from the material from which the disparate test results were obtained, and randomly assigned in equal numbers to each laboratory for testing. The test results from the two laboratories should be compared using a statistical test for unpaired data, at a probability level chosen prior to the testing series. If a bias is found, either its cause must be found and corrected, or future test results for that material must be adjusted in consideration of the known bias.

5.2 The frictional properties of textile yarns and of machinery components such as yarn guides are of general interest and have many applications. Because the frictional properties of yarns will affect the performance and life of yarn guides, sewing and knitting needles, and other contact surfaces, the modifying effects of surface finishes and lubricants are of special interest. Frictional properties also affect the quality and performance properties of yarns and subsequently of products made from them. As a consequence, frictional properties are of interest in research, control, and product design.

5.3 It is stressed that there is no coefficient of friction for a single body such as a yarn or a surface. A coefficient of friction measures the interaction between two bodies or elements such as a yarn running over a surface.

5.4 Although this method lays down standardized conditions of test, nonstandard conditions may be used for research or diagnosis but should be reported as such.

5.5 This method covers determination of the mean friction over a specified length of yarn.

5.6 Additional information has been reported in the literature.[3,4,5]

6. Apparatus

6.1 *Friction Testing Apparatus (Indirect)*[6] (Fig. 2)—Apparatus in which the input tension is measured or controlled to a set value, the output tension is measured, and the coefficient of friction is calculated within or outside the apparatus.

6.1.1 *Yarn Tension Input Control*—A means of controlling the yarn input tension to the nearest ±1 mN [±0.1 gf]. A demand-fed apparatus with a fixed weight is suitable.

6.1.2 *Yarn Input Tension Measurement*—The yarn input tension is measured to within ±1 mN [±0.1 gf] using a suitable tension gage producing an electrical signal. The signal is recorded as mN [gf], or is used in combination with the yarn output tension measurement to calculate the coefficient of friction.

6.1.3 *Yarn Output Tension Measurement*—The yarn output tension is measured to within ±1 mN [±0.1 gf] using a

[3] Olsen, J. S., "Frictional Behaviour of Textile Yarns," *Textile Research Journal*, Vol 39, No 1, 1969, pp 31–37.

[4] Lyne, D.G., "Dynamic Friction Between Cellulose Acetate Yarn and a Metal Cylinder," *Journal of the Textile Institute*, Vol 46, 1955, p 112.

[5] Rubenstein, C., "Review of the Factors Influencing the Friction of Fibres, Yarns and Fabrics," *Wear*, Vol 2, 1958-59, p 296.

[6] Equipment meeting these requirements may be commercially obtained from Lawson Hemphill (Sales) Inc., PO Drawer 6388, Spartanburg, SC 29304.

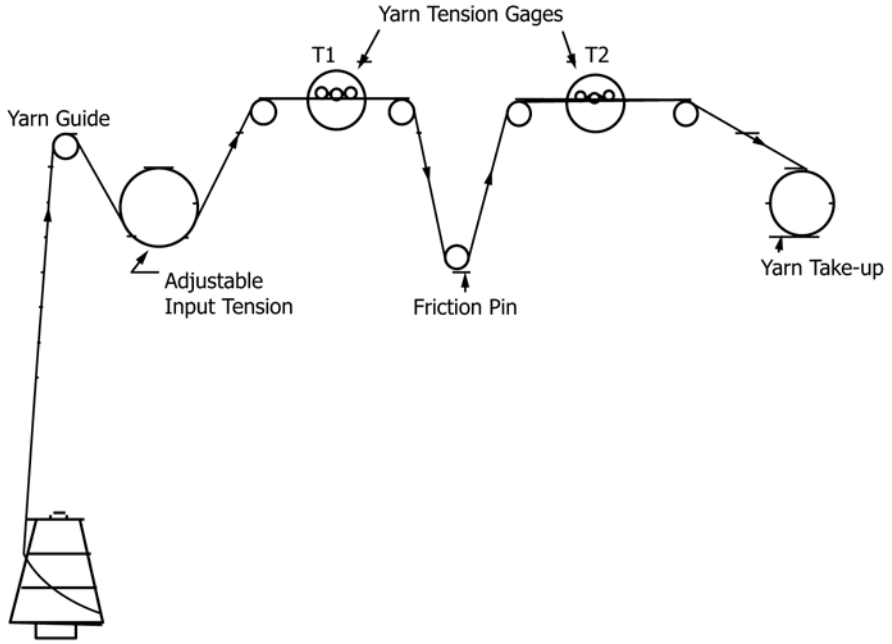

FIG. 2 Schematic Diagram of Typical Yarn Friction Measuring Apparatus, Indirect Type

suitable tension gage producing an electrical signal. The signal is recorded as mN [gf] or is used in combination with the yarn input tension measurement to calculate the coefficient of friction. A suitable chart recorder may be used.

6.2 *Friction Testing Apparatus (Direct)* (Fig. 3)—Apparatus in which the ratio of output to input tensions is established directly and the coefficient of friction indicated on a scale or display. The comparison may be mechanical.

6.2.1 *Yarn Tension Input Control*—Since this type of apparatus automatically derives the ratio of output-to-input-tension, close control of input tension is not usually required. However, because the absolute level of input tension can affect the measured coefficient of friction for certain yarns, particularly low-twist yarns, the general level of input tension should be preset, for example with a dead weight disk tensioner.

6.2.2 *Coefficient of Friction Indicator*—The nature of this will depend on the instrument being used. Typically, a pointer or a chart recorder pen is displaced by the movement of the components that bring the system into balance and the product of the input tension and the distance from the axis equals the product of the output tension and the distance from the axis (see Fig. 3).

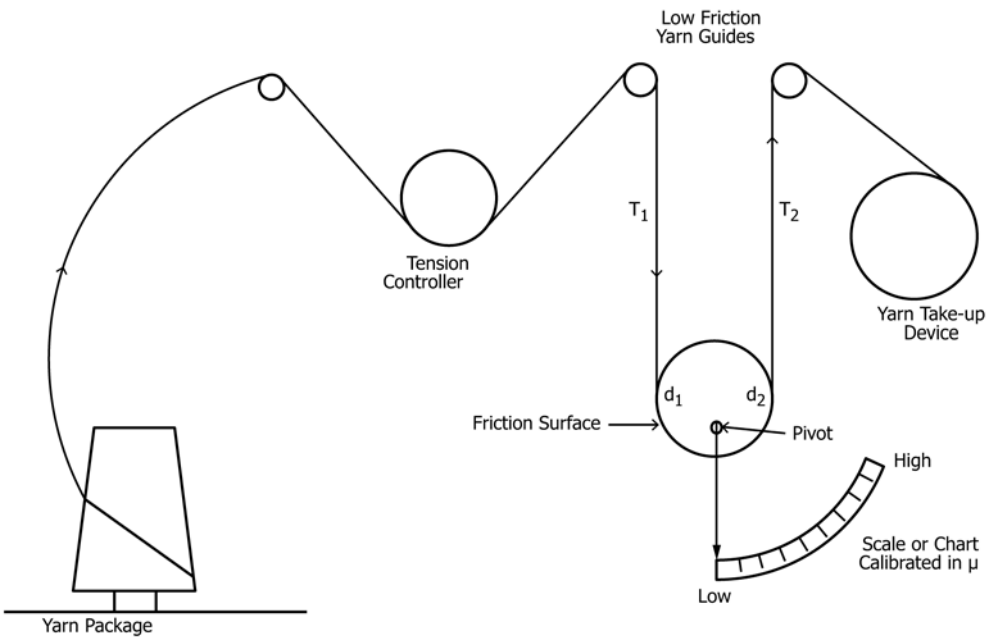

FIG. 3 Schematic Diagram of Typical Yarn Friction Measuring Apparatus, Direct Type