Designation: D 3108 – 95

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

This standard is issued under the fixed designation D 3108; 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 D 3412.

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 3.14 and 6.28 radian (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 10 and 80 tex (90 and 720 denier) and having coefficients of friction ranging between 0.1 and 0.5 but may also be used with yarns outside these ranges of linear densities and coefficients of friction.

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

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.* Specific precautionary statements are given in Section 7.

2. Referenced Documents

2.1 *ASTM Standards:*

D 123 Terminology Relating to Textiles[2]

D 1776 Practice for Conditioning Textiles for Testing[2]

D 1907 Test Method for Yarn Number by the Skein Method[2]

D 2258 Practice for Sampling Yarn for Testing[2]

D 3412 Test Method for Coefficient of Friction, Yarn to Yarn[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *coefficient of friction, n*—the ratio of the tangential force that is needed to maintain uniform relative motion between two contacting surfaces to the perpendicular force holding them in contact.

3.1.2 *friction, n*—the resistance to the relative motion of one body sliding, rolling, or flowing over another body with which it is in contact.

3.1.2.1 *Discussion*—There are two frictional properties exhibited between any pair of surfaces: static friction and kinetic friction. Test Methods D 3108 and D 3412 both measure the coefficient of friction for kinetic friction.

3.1.3 *kinetic friction, n*—friction developed between two bodies in motion. (Compare *Static friction*.)

3.1.4 *radian, n*—the plane angle between two radii of a circle which intersects the circumference of the circle making an arc equal in length to the radius.

3.1.4.1 *Discussion*—A radian is equal to 180° divided by Π and is approximately 57.3°.

3.1.5 *static friction, n*—friction developed between two touching bodies at the time one body starts to move relative to another. (Compare *Kinetic friction*.)

3.1.6 *wrap angle, n—in yarn friction testing*, the cumulative angular contact of the test specimen against the friction-inducing device, expressed in radians.

3.1.7 For definitions of other textile terms used in this test method, refer to Terminology D 123.

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

[1] This test method is under the jurisdiction of ASTM Committee D-13 on Textiles and is the direct responsibility of Subcommittee D13.58 on Yarn Test Methods, General.

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[2] *Annual Book of ASTM Standards*, Vol 07.01.

[3] *Annual Book of ASTM Standards*, Vol 07.02.

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 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 D 3108 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 In case of a dispute arising from differences in reported test results when using Test Method D 3108 for acceptance testing of commercial shipments, the purchaser and the supplier should conduct comparative tests to determine if there is a statistical bias between their laboratories. Competent statistical assistance is recommended for the investigation of bias. As a minimum, the two parties should take a group of test specimens which are as homogeneous as possible and which are from a lot of material of the type in question. The test specimens should then be randomly assigned in equal numbers to each laboratory for testing. The average results from the two laboratories should be compared using Student's *t*-test for unpaired data and an acceptable probability level chosen by the two parties before the testing is begun. If a bias is found, either its cause must be found and corrected, or the purchaser and the supplier must agree to interpret future test results with consideration to 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.[4,5,6]

6. Apparatus

6.1 *Friction Testing Apparatus (Indirect)*[7] *(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.

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

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

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

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

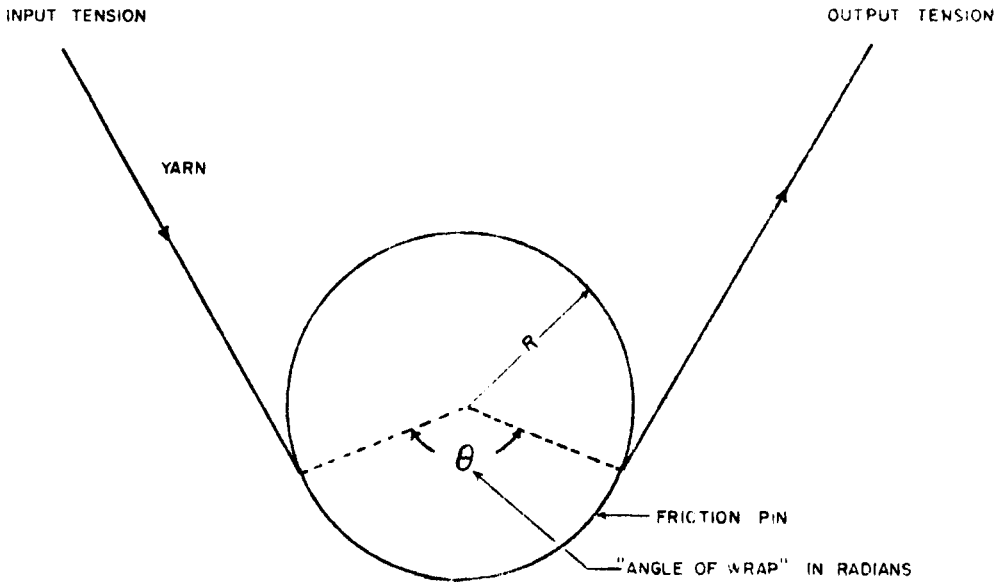

FIG. 1 Schematic Diagram of Angle of Wrap

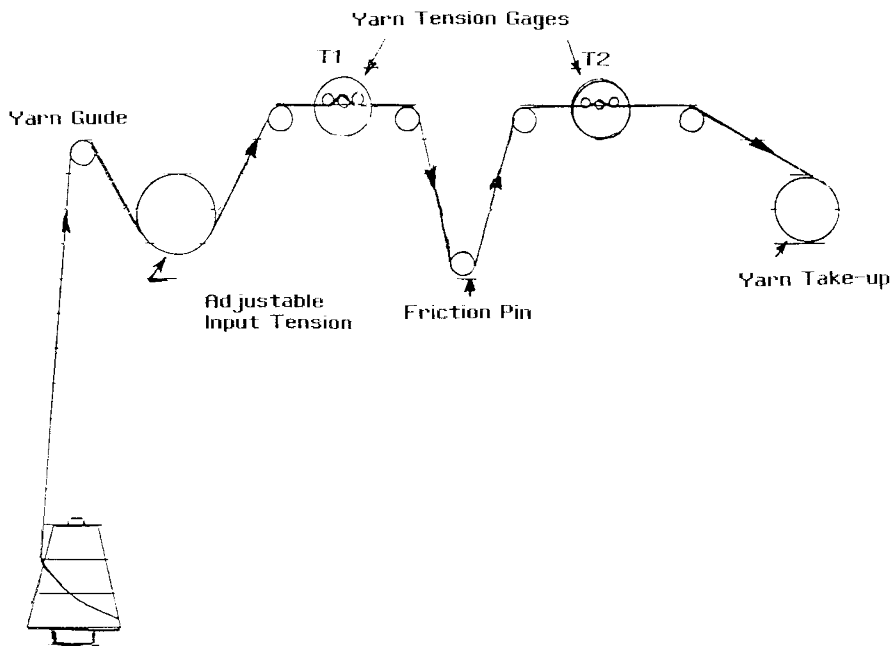

FIG. 2 Schematic Diagram of Typical Yarn Friction Measuring Apparatus, Indirect Type

6.1.3 *Yarn Output Tension Measurement*—The yarn output 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 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).

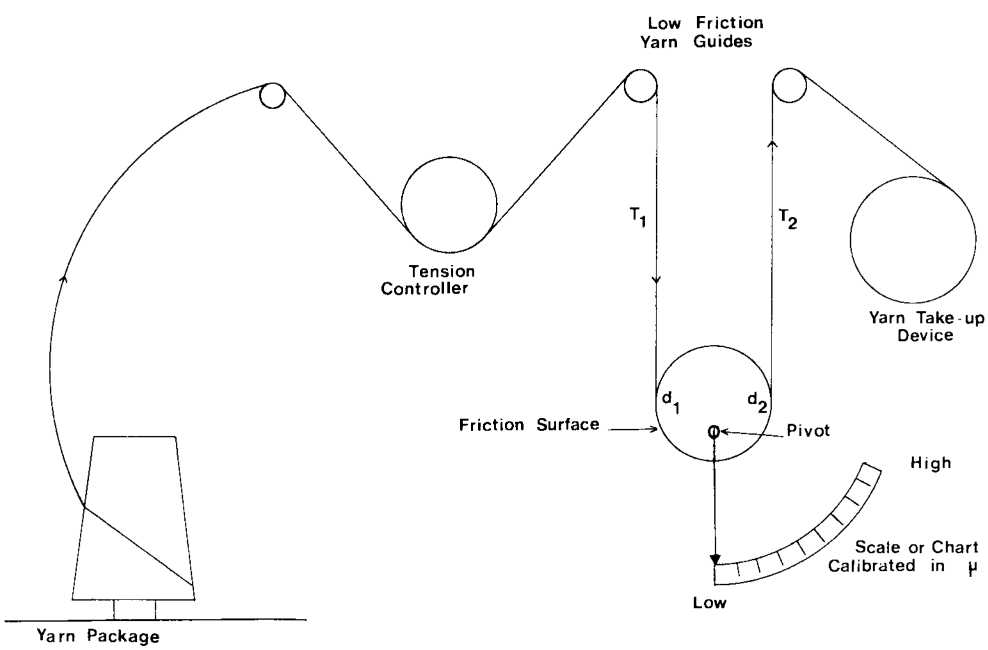

FIG. 3 Schematic Diagram of Typical Yarn Friction Measuring Apparatus, Direct Type