Designation: D 4120 – 01

Standard Test Method for
Fiber Cohesion in Roving, Sliver, and Top in Dynamic Tests[1]

This standard is issued under the fixed designation D 4120; 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 describes the measurement of fiber cohesion as the dynamic cohesive force required to maintain drafting in rovings, slivers or tops when they are subjected to stress induced by passing between pairs of drafting rolls of different surface speeds. The cohesive force is converted to cohesive tenacity based on the linear density of the material.

NOTE 1—For static tests refer to Test Method D 2612.

1.2 *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 123 Terminology Relating to Textiles[2]

D 519 Test Method for Length of Fiber in Wool Top[2]

D 1440 Test Method for Length and Length Distribution of Cotton Fibers (Array Method)[2]

D 1447 Test Method for Length and Length Uniformity of Cotton Fibers by Fibrograph Measurement[2]

D 1575 Test Method for Fiber Length of Wool in Scoured Wool and in Card Sliver[2]

D 1776 Practice for Conditioning and Testing Textiles[2]

D 2258 Practice for Sampling Yarn for Testing[2]

D 2612 Test Method for Fiber Cohesion in Sliver and Top in Static Tests[2]

D 3333 Practice for Sampling Manufactured Staple Fibers, Sliver, or Tow for Testing[3]

D 4848 Terminology of Force, Deformation and Related Properties[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *cohesive force*, *n*—*in a textile strand*, the force required to overcome fiber cohesion as the strand is being reduced in linear density.

3.1.1.1 *Discussion*—In dynamic tests, cohesive force is the force required to maintain drafting in a roving, sliver, or top. In static tests, cohesive force is measured while a test specimen is held in fixed position between two slowly separating clamps.

3.1.2 *fiber cohesion*, *n*—*in textiles*, the resistance to separation of fibers in contact with one another.

3.1.2.1 *Discussion*—This resistance is due to the combined effects of the surface characteristic, length, crimp, finish, and linear density of the fibers. Cohesion should not be confused with adhesion or sticking together as in a glutinous substance.

3.1.3 *roving*, *n*—a loose assemblage of fibers drawn or rubbed into a single strand, with very little twist. In spun yarn systems, the product of the stage, or stages, just prior to spinning.

3.1.4 *sliver*, *n*—a continuous strand of loosely assembled fibers that is approximately uniform in cross-sectional area and without twist.

3.1.5 *tenacity*, *n*—*in a tensile test*, the force exerted on the specimen based on the linear density of the unstrained material.

3.1.6 *top*, *n*—*(1) worsted process* —a sliver in which the fibers have been parallelized, and usually combed; (*2*) *manufactured fibers or tow to top process*—a sliver obtained by drafting, along with breaking or cutting a multifilament tow.

3.1.7 For definitions of terms related to force and deformation in textiles refer to Terminology D 4848. For definitions of other textile terms used in this test method refer to Terminology D 123.

4. Summary of Test Method

4.1 This test method provides an indication of the ability of fibers to hold together by measuring the force required to slide fibers in a direction parallel to their length. Specific lengths of roving, sliver, or top are drafted between two pairs of rollers, with each pair moving at a different peripheral speed. The draft forces are recorded. Test specimens are then weighed and the linear density calculated. Drafting tenacity, calculated as the draft resisting force per unit linear density, is considered to be a measure of the dynamic fiber cohesion.

5. Significance and Use

5.1 Test Method D 4120 for the determination of cohesion in sliver, roving, or top in dynamic tests may be used for the acceptance testing of commercial shipments but caution is advised since information on between-laboratory precision is

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

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

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

lacking. 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 test 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 homogeneous 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 compare 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 cohesive forces overcome in continuous drafting of slivers, rovings, or tops are affected by surface lubricants and such fiber properties as linear density, surface configuration, fiber length, fiber crimp, and fiber-frictional characteristics.

5.2.1 The concept of drafting is one of the most important principles in the production of yarn from fibrous raw stock.

5.2.2 The values of force to maintain drafting determined by this method are induced by mechanical means similar to those used in textile processing.

5.2.3 The attenuation of textile fiber strands while in motion closely approximates actual textile processing conditions, and the relative values of force may be used to predict processing behaviors.

5.3 Fiber cohesion is affected by the alignment of fiber in the textile strand and strand compaction in addition to the factors listed in 5.2. Although fibers are more nearly aligned in draw sliver than in card sliver, the draw sliver is more compact. Thus, for a given production run, the drafting forces are higher for draw sliver than for card sliver.

5.4 In addition to the aforementioned effects on drafting forces, the direction of specimen movement through drafting rollers may give different drafting force. Fibers in slivers may have hooks of varying severity at one or both ends. Passage through drafting rollers results in higher drafting forces when the predominance of fiber hooks are oriented in the trailing mode of the strand.

6. Apparatus and Materials

6.1 *Cohesion Meter*[4], with rollers and controls for varying drafts and rates of drafting.

6.2 *Tensiometer*[4], with accessory equipment including measuring heads, integrator, (or computer or programmable calculator), and recorder for sensing, accumulating, and recording drafting forces.

6.3 *Calibration Mass*, 1 kg, NBS Class T.

6.4 *Tachometer*, capable of measuring roll surface speed to within 0.1 m/min.

6.5 *Balance*, with sufficient capacity and sensitivity to weigh specimens to within 0.1 % of specimen mass.

[4] Instruments and accessories meeting these requirements are manufactured by Rothschild, Zurich, Switzerland, and may be obtained from Lawson-Hemphill Sales, Inc., P.O. Drawer 6388, Spartanburg, SC 29304.

7. Sampling

7.1 *Lot Sampling*—As a lot sample for acceptance testing, take at random the number of shipping containers directed in the applicable material specification or other agreement between the purchaser and supplier, such as an agreement to use Practice D 3333 or Practice D 2258. Consider shipping containers to be the primary sampling units.

NOTE 2—An adequate specification or other agreement between the purchaser or supplier requires taking into account the variability between shipping units, between packages, ends or other laboratory sampling unit within a shipping unit if applicable, and within specimens from a single package, end or other laboratory sampling unit to provide a sampling plan with a meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quantity level.

7.2 *Laboratory Sample*—As a laboratory sample for acceptance testing, take at random from each shipping container in the lot sample the number of laboratory sampling units as directed in an applicable material specification or other agreement between purchaser and supplier such as an agreement to use Practice D 3333 or Practice D 2258. Preferably, the same number of laboratory sampling units are taken from each shipping container in the lot sample. If differing numbers of laboratory sampling units are to be taken from shipping containers in the lot sample, determine at random which shipping containers are to have each number of laboratory units drawn.

7.2.1 Each laboratory sampling unit should be at least 100 m long.

7.3 *Test Specimens*—From each laboratory sampling unit, take one specimen. If the standard deviation determined for the laboratory sample is more than a value agreed upon between the purchaser and supplier, continue testing one specimen from each unit in the laboratory sample until the standard deviation for all specimens tested is not more than the agreed to value or, by agreement, stop testing after a specified number.

8. Preparation and Calibration of Equipment

8.1 Install the tensiometer measuring head in the cohesion meter. Selection of the proper capacity head may be determined by trial tests on the materials to be tested, or previous experience with a given product.

8.2 Calibrate the apparatus as directed in the manufacturer's instructions.

8.3 Verify the input and output speeds using a tachometer.

8.4 Unless otherwise directed, set the draft ratio for 1.25, the material input speed to 5 m/min, the timer to give an input test length of 10 m and the integration period for 1 min.

8.5 Set the gage spacing of the drafting rollers for 1.4× the mean staple length of the fiber in the test specimen.

8.5.1 Use the staple length determined using Test Method D 1440 or Test Method D 1447 for cotton, or the staple length assigned by the fiber producer to manufactured fibers developed for processing on the cotton system. For wool or manufactured fibers with great variability in their length distribution and developed for processing on a long staple fiber system, use the fiber length which includes 95 % of the fibers in the specimen as determined from a fiber sorting, using Test Methods D 519, or D 1575.

9. Conditioning

9.1 Precondition and condition the laboratory samples as directed in Practice D 1776.

10. Procedure

10.1 Test the adequately conditioned specimens in the standard atmosphere for testing textiles that is 21 ± 1°C (70 ± 2°F) and 65 ± 2 % relative humidity.

10.2 With instrument at slow speed (2 m/min), start test by pressing CONTINUOUS RUN button on the cohesion meter and threading the specimen strand through input rollers, around measuring head guide roller and through output (delivery) rollers.

10.3 Operate 10 to 15 s, or long enough for slack to be removed from strand and tension to build up on measuring head. Turn the tensiometer range selector switch to the position which most nearly keeps the galvanometer needle at mid-scale. Change speed to 5 m/min, press timer to start the automatic 10 m test length and immediately cut the specimen strand even with the front edge of the discharge chute.

10.4 If an on-line computer or programmable calculator is used, run for 1 min taking a minimum of 50 readings, or,

10.4.1 If an integrator is used, press the SINGLE push button and record the integrator value when the cohesion meter automatically stops at the 10-m length.

10.5 Cut the delivered specimen strand even with the front edge of the discharge chute and weigh to the nearest 0.1 g.

10.6 Continue as directed in 10.2-10.5 until the necessary number of specimens have been tested.

11. Calculation

11.1 Calculate the dynamic cohesion as the cohesive tenacity of each specimen to the nearest 0.1 mgf/tex, using Eq 1.

$$\text{Cohesive tenacity, mgf/tex} = F \times L/M \quad (1)$$

where:

F = drafting force, gf,
L = specimen length, m, and
M = specimen mass, g.

NOTE 3—Drafting tenacity as micronewtons per tex (μN/tex) is numerically equal to drafting tenacity as mgf/tex times 9.81.

11.2 Calculate the average drafting tenacity for each laboratory sample testing direction and for the lot sample to the nearest 0.1 mgf/tex.

11.3 Calculate the standard deviation, the coefficient of variation, or both, for the laboratory sample and the lot sample, if requested.

12. Report

12.1 State that the specimens were tested as directed in ASTM Test Method D 4120. Describe the materials tested by fiber type, staple length, nominal linear density of the fibers in the material (if known), crimp of the fibers (if known), processing step from which the material was obtained, and method of sampling used.

12.2 Report the following information:

12.2.1 The number of specimens tested in each laboratory sample testing direction,

12.2.2 The average cohesive tenacity for each laboratory sample testing direction,

12.2.3 The average cohesive tenacity for the lot sample, and

12.2.4 The standard deviation, coefficient of variation, or both, for each laboratory sample testing direction and the lot sample, if calculated.

13. Precision and Bias

13.1 *Precision*—The precision for measuring fiber cohesion in dynamic tests as drafting tenacity is being determined.

13.2 *Bias*—The value for dynamic fiber cohesion as measured by drafting tenacity can only be defined in terms of specific methods. Within this limitation, the procedure in Test Method D 4120 for determining this property has no known bias.

14. Keywords

14.1 fiber cohesion; textile strand