Designation: D828 – 22

Standard Test Method for Tensile Properties of Paper and Paperboard Using Constant-Rate-of-Elongation Apparatus[1]

This standard is issued under the fixed designation D828; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This test method covers procedures for determining tensile properties of paper and paperboard.

1.2 The procedures given in this test method are for use with constant-rate-of-elongation tensile testing equipment and as such, are able to be used with instruments designed for either vertical or horizontal operation, and whether manually operated or computer controlled.

1.3 These procedures are applicable for all types of paper, paperboard, paper products, and related materials within the measurement limitations of the equipment used. They are not for use with combined corrugated board.

1.4 Properties able to be determined using this test method include tensile strength, stretch, tensile energy absorption, tensile stiffness, breaking length, and tensile index.

1.5 The values stated in SI units are to be regarded as the standard. The inch-pound units 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *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]

D585 Practice for Sampling and Accepting a Single Lot of Paper, Paperboard, Fiberboard, and Related Product (Withdrawn 2010)[3]

D685 Practice for Conditioning Paper and Paper Products for Testing

D987 Test Method for Test for Stretch of Paper and Paper Products Under Tension (Withdrawn 1968)[3]

D1968 Terminology Relating to Paper and Paper Products

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:* For definitions of terms used in this test method, refer to Terminology D1968 or the *Dictionary of Paper*.[4]

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *line contact grips, n*—grips or jaws on a tensile testing machine having a clamping zone for gripping the specimen comprised of a cylindrical and a flat surface or two cylindrical surfaces whose axes are parallel.

3.2.2 *paper, n*—planar structures deposited from an aqueous suspension that has a thickness less than 1 mm containing organic material, nonorganic material, or a combination of the two.

4. Significance and Use

4.1 The tensile properties measured in this test method are fundamental properties associated with the manufacture, or end

[1] This test method is under the jurisdiction of ASTM Committee D09 on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee D09.01 on Electrical Insulating 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] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from the Technical Association of the Pulp and Paper Industry, PO Box 105113, Atlanta, GA 30348.

use, or both, of paper and paper products. It is possible for products to be influenced by, or indicative of: the type fibers used or the treatment of the fibers, or both, in a particular paper: or of specific manufacturing procedures used in producing a specific paper or paper product. Likewise, it is possible for paper converting operations to significantly impact properties measured using this test method, and this test method is a possible tool to measure and understand such effects.

4.2 Tensile strength is indicative of the serviceability of many papers, such as wrapping, bag, gummed tape, and cable wrapping, that are subjected to direct tensile stress. The tensile strength of printing papers is indicative of the potential resistance to web breaking during printing and other converting operations and during travel of the web from the roll through the equipment.

4.3 Stretch, and sometimes tensile stiffness are indicative of the ability of the paper to conform to a desired contour. These are important properties of creped papers, towels, napkins, decorative papers, industrially used paper tapes (both creped and pleated), bags, and liners for cans, barrels, and cartons.

5. Apparatus

5.1 *Tensile Testing Machine,* of the constant-rate-of elongation type conforming to the following criteria:

5.1.1 Two line contact grips or jaws for gripping the test specimens, with the line of contact perpendicular to the direction of the applied load, and with means for controlling and adjusting the clamping pressure.

NOTE 1—There is the possibility that are certain grades of paper that will be damaged by line contact grips. In these cases, as agreed upon between the users of this test method, it is allowable for other grips to be substituted, and that fact stated in the report.

5.1.1.1 The clamping surfaces of the two grips must be in the same plane and so aligned that they hold the test specimen in that plane throughout the test.

5.1.2 The distance between the line contact gripping zones of the grips at the beginning of a test must be adjustable and resettable to ±0.5 mm (±0.02 in.) for the specified initial test span (see 8.1 and 10.3.2).

5.1.3 The rate of separation of the two grips must be 25.4 mm/min ± 5.0 mm/min (1.0 in./min ± 0.2 in./min) or as otherwise noted (see 10.3.4), and once set, must be resettable and constant at the required rate to ±4 % of the specified value.

5.1.4 The tensile testing machine must be equipped with a load measuring device and a recorder or other suitable indicator of the measured load at points of interest during the test, an example of which might be a micro processor and digital readout device or cathode ray tube screen, capable of reading the measured loading force accurately to 0.25 % of the full range of the load measuring device. The load measuring circuitry must be capable of accurate calibration, and must maintain that calibration accuracy to ±0.5 % of the full-scale value.

5.1.5 The tensile testing machine must be equipped with an elongation measuring device and a recorder or other suitable indicator of the measured elongation at points of interest, an example of which might be a microprocessor and digital readout device or cathode ray tube screen, capable of accurate calibration and of indicating the elongation values to a readability and accuracy of ±0.05 % stretch (that is ±0.09 mm elongation for an original specimen test span of 180 mm).

5.1.6 The tensile testing machine must be capable of providing the measurement data required for making the calculations specified in Section 11, whether by presentation of data in the form of a recorder trace of the tensile force-elongation behavior of the material being tested such that data required by the user is able to be readily determined from the recorder trace, or whether by storage of required data points in a form usable and retrievable by the user for calculations as specified in Section 11, or whether by including calculation algorithms suitable for direct display of the calculations specified in Section 11. Where calculation algorithms are included, it is the responsibility of the manufacturer of the instrument to clearly document the calculation basis for the values that are reported, and that they do or do not comply with the calculations specified in Section 11. The user of the instrument must, in turn, determine that reported values are suitable for any particular information need. Numerous other calculations are possible, based on the tensile strength-elongation of a material, and are permissible to be included in an instrument used for making the measurements described in this test method, as agreed upon between the manufacturer and the purchaser of the instrument.

5.2 *Alignment Jig,* to facilitate centering and aligning the specimen in the instrument grips, so that the clamping lines of contact are perpendicular to the direction of the applied force and the center line (long dimension) of the specimen coincides with the direction of the applied force. Use optional, as agreed upon between the users of this test method. Such a device is described in TAPPI Journal (**1**).[5]

5.3 *Planimeter or Integrator,* to measure the area beneath the load-elongation curve or to compute directly the work to rupture. The specific characteristics of the testing machine used will dictate the need for this device. Most modern electronic tensile testing machines include the necessary calculation capabilities in the software resident in the instrument. See 5.1.6.

5.4 Specimen Cutter, a device capable of cutting specimens for testing that are uniform in width to within at least ±0.5 mm (±0.02 in.) or less of the specified specimen width, and with edges parallel to within 0.1 mm (0.004 in.). The double-blade strip cutter of the JDC-type is quite satisfactory for this requirement. Cutting dies, that comply with or exceed the tolerances stated herein, are an acceptable alternative the guillotine style cutter mentioned above. Single-blade "paper cutters" do not comply with the requirements for a specimen cutter for purposes of this test method.

5.5 *Magnifier and Scale or Similar Optical Comparator,* for use in measuring specimen widths and determining that specimens comply with 5.4. It is important to understand that the requirements of 5.4 apply to the test specimen, not to the specimen cutter. The tolerances to which the cutter or cutting

[5] The boldface numbers in parentheses refer to the list of references at the end of this standard.