Designation: D 528 – 97 (Reapproved 2002)

An American National Standard

Standard Test Method for Machine Direction of Paper and Paperboard[1]

This standard is issued under the fixed designation D 528; 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 four procedures for determining the machine direction of most grades of paper and paperboard, embodying the principle that machine direction alignment of fibers results in:

1.1.1 Cross-direction shrinkage to produce curl with axis in machine direction,

1.1.2 Higher cross-direction tear,

1.1.3 Higher tensile strength in machine direction, and

1.1.4 Higher stiffness in machine direction.

1.2 Application of the procedures in this method to certain grades of paper, such as sheets laminated to film, creped papers, extensible papers (where it is not unusual for the machine direction tensile to be relatively low and the stretch to be relatively high) and papers reinforced with textile materials, may result in unreliable determinations.

1.3 *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 585 Practice for Sampling and Accepting a Single Lot of Paper, Paperboard, Fiberboard, or Related Product[2]

D 774 Test Method for Bursting Strength of Paper[2]

D 828 Test Method for Tensile Properties of Paper and Paperboard Using Constant-Rate-of-Elongation Apparatus[2]

D 1968 Terminology Relating to Paper and Paper Products[2]

2.2 *TAPPI Standard:*

T 409 Machine direction of paper[3]

3. Terminology

3.1 *Definitions*—Definitions shall be in accordance with Terminology D 1968 and the *Dictionary of Paper.*[3]

4. Summary of Test Method

4.1 This test method describes four physical procedures for determining the machine direction of paper and paperboard. Two of the procedures employ no special apparatus, the one using the difference in stiffness between machine and cross directions, and the other utilizing the tendency of paper to curl when preferentially wetted on one side. The remaining two procedures use standard test equipment, a tensile tester in one case and a bursting tester in the other.

5. Significance and Use

5.1 From the standpoint of use requirements, the determination of the machine direction of paper is essential where creasing is required, such as the folding of pages in books and pamphlets, or when scoring or creasing is performed as for cut-outs and folders.

5.2 Determination of machine direction is necessary, in many instances, before further testing can be done. For example, machine direction must be known when determining brightness, gloss, tear, tensile and folding endurance.

6. Apparatus

6.1 *Bursting Tester*, meeting the requirements set forth in Test Method D 774, to be used for Procedure C.

6.2 *Tensile Tester*, meeting the requirements set forth in Test Method D 828, to be used for Procedure D.

6.3 *Other Apparatus*—Indelible pencil (optional for 9.1), shallow glass or metal pan.

7. Sampling and Test Specimens

7.1 Obtain a sample of the paper in accordance with Practice D 585. From each test unit sheet of the sample prepare specimens as follows:

7.1.1 *Procedure A*—For purposes of identification, draw a line through adjacent parts of the paper and the specimen to be cut. Cut circular specimens approximately 50 mm in diameter or square specimens approximately 50 mm on a side. For

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[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 Test Methods.

Current edition approved Dec. 10, 1997. Published November 1998. Originally published as D 528 – 39T. Last previous edition D 528 – 95$^{\epsilon 1}$.

[2] *Annual Book of ASTM Standards*, Vol 15.09.

[3] Available from the Technical Association of the Pulp and Paper Industry, Technology Park/Atlanta, P.O. Box 105113, Atlanta, GA 30348.

square specimens, the sides of the specimen must be cut parallel to the sides of the test unit sheet.

7.1.2 *Procedures B and D*—Cut two test specimen strips 15 by 250 mm. Cut them at right angles to each other and parallel to the edges of the test unit sheet.

7.1.3 *Procedure C*—Use the test unit sheet as received.

8. Procedure

8.1 *Procedure A*—Float a specimen on tap water in a pan and note or mark with an indelible pencil, the final axis of curl. Observe the curl before water penetrates completely through the specimen.

8.2 *Procedure B—Bend*—Place two specimen strips together, one on top of the other, making sure they are aligned at one end. Grasp the two between the thumb and forefinger and hold them so that they are free to bend of their own weight. Repeat, placing the bottom specimen on top. Note which specimen bends more when it is placed on the bottom.

8.3 *Procedure C—Bursting Test*—Perform a bursting test on the test unit sheet in accordance with Test Method D 774. Remove the test unit sheet from the bursting tester and observe the principal line of rupture.

8.4 *Procedure D—Tensile Test*—Perform tensile tests on the specimens in accordance with Test Method D 828.

8.5 *Recommendations for Procedures*:

8.5.1 Procedures A and C are recommended when the test unit is not in square cut sheet form or where it is not certain that the edges of the test unit are parallel to the machine and cross directions.

8.5.2 Procedure A may not be applicable to unsized papers.

8.5.3 A modification of Procedure D can be also used where the test unit is not square cut or where it is not certain that the edges of the test unit are parallel to the machine and cross directions. Cut consecutive test specimens at 0, 30, 60, 90, 120, and 150° from an arbitrarily selected reference line. The specimen having the greatest tensile strength can be considered to have its length parallel to the machine direction. This will not apply to extensible papers.

9. Interpretation of Results

9.1 The axis of curl in Procedure A will be parallel to the machine direction of paper. Papers with a high degree of dried-in strain may first exhibit an axis of curl in the cross direction. After strain relaxation, the curl axis changes and parallels the machine direction.

9.2 The specimen in Procedure B cut with its length parallel to the cross direction, will bend more because of the lesser cross-direction stiffness and will, when on the bottom, fall away from the specimen cut with its length parallel to the machine direction.

9.3 The principal line of rupture in Procedure C (with approximately perpendicular fractures at either end) will be perpendicular to the machine direction.

NOTE 1—The bursting test is convenient for papers with a normal distribution of tensile and stretch characteristics; however, there are numerous exceptions to this. The principal line of rupture is parallel to the direction with the higher stretch. In those papers where there is no significant difference in the stretch for the two directions, the rupture tends to be more random and less positive.

9.4 The specimen in Procedure D, cut with its length in the machine direction, will normally have the greater tensile strength and the lesser stretch.

10. Precision and Bias

10.1 No information is presented about either the precision or bias of this test method since the test result is nonquantitative.

11. Keywords

11.1 cross machine direction; machine direction; paperboard