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Tissue paper and tissue products —

Part 4: Determination of tensile strength, stretch at break and tensile energy absorption

Papier tissu et produits en tissu —

Partie 4: Détermination de la résistance à la rupture par traction, de l'allongement à la rupture par traction et de l'absorption d'énergie à la rupture par traction

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 12625-4 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 172, *Pulp, paper and board*, in collaboration with Technical Committee ISO/TC 6, *Paper, board and pulps*, Subcommittee SC 2, *Test methods and quality specifications for paper and board*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This first edition cancels and replaces EN 12625-4:1999, which has been technically revised.

With regard to EN 12625-4:1999, the following changes have been made:

a) a more precise definition of the measurement was added;

b) “preparation of test pieces” was explained more exactly;

c) editorial updating.

ISO 12625 consists of the following parts, under the general title *Tissue paper and tissue products*:

— *Part 1: General guidance on terms*

— *Part 3: Determination of thickness, bulking thickness and apparent bulk density*

— *Part 4: Determination of tensile strength, stretch at break and tensile energy absorption*

— *Part 5: Determination of wet tensile strength*

— *Part 6: Determination of grammage*

— *Part 7: Determination of optical properties*

— *Part 8: Water absorption time and water absorption capacity, basket immersion test method*

— *Part 9: Determination of ball burst strength*

Tissue paper and tissue products —

Part 4:
Determination of tensile strength, stretch at break and tensile energy absorption

1 Scope

This part of ISO 12625 specifies a test method for the determination of the tensile strength, stretch at break and tensile energy absorption of tissue paper and tissue products. It uses a tensile-testing apparatus operating with a constant rate of elongation.

It also specifies the method of calculating the tensile index and the tensile energy absorption index.

It is expressly stated that the detection of impurities and contraries in tissue paper and tissue products should be applied according to ISO 15755.

For the determination of moisture content in tissue paper and tissue products, ISO 287 should be applied.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 186, *Paper and board — Sampling to determine average quality*

ISO 187, *Paper, board and pulps — Standard atmosphere for conditioning and testing and procedure for monitoring the atmosphere and conditioning of samples*

ISO 536, *Paper and board — Determination of grammage*

ISO 1924-2:1994, *Paper and board — Determination of tensile properties — Part 2: Constant rate of elongation method*

ISO 7500-1, *Metallic materials — Verification of uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system*

ISO 12625-1, *Tissue paper and tissue products — Part 1: General guidance on terms*

ISO 12625-6, *Tissue paper and tissue products — Part 6: Determination of grammage*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12625-1 and the following apply.

3.1
tensile strength
maximum tensile force per unit width that a test piece will withstand before breaking in a tensile test

3.2
tensile index
tensile strength divided by grammage

3.3
stretch at break
ratio of the elongation of a test piece, over its initial length, at the moment when the maximum tensile force is reached during a tensile test

NOTE Stretch at break is expressed as a percentage of the initial length.

3.4
tensile energy absorption
amount of energy absorbed per unit surface area of a test piece while being stretched, until the onset of break (the moment of maximum tensile force) in a tensile test

3.5
tensile energy absorption index
tensile energy absorption divided by grammage

[ISO 1924-2:1994]

4 Principle

A test piece of tissue paper or a tissue product, of given dimensions, is stretched to break at a constant rate of elongation using a tensile-testing apparatus that measures and records the tensile force as a function of the elongation of the test piece.

From the recorded data, the tensile strength, the corresponding stretch at break, and the tensile energy absorption are calculated.

5 Apparatus

5.1 Tensile-testing apparatus

The tensile-testing apparatus shall be in accordance with ISO 1924-2. It is capable of stretching a test piece of tissue paper or tissue product of given dimensions, at a constant rate of elongation of (50 ± 2) mm/min, and recording the tensile force as a function of elongation on a strip chart recorder or any equivalent device.

The elongation shall be recorded to an accuracy of ± 0,1 mm. The measurement of the elongation shall start at a tension of (5 ± 1) N/m.

The force-measuring system shall measure loads with an accuracy of ± 1 % of the reading or ± 0,05 N, whichever is the greater. It shall be calibrated and verified in accordance with the requirements of ISO 7500-1.

5.1.1 Means for measuring the area of the force-elongation curve

The tensile-testing apparatus shall provide a means for measuring the area between the force-elongation curve and the elongation axis, to an accuracy of ± 2 % of the true value. Most modern tensile testers are equipped with an electronic or electro-mechanical integrator that can be used for this purpose. The area may also be determined from a graphical output of the data on chart paper using a planimeter.

5.1.2 Tensile-tester clamps

The tensile-testing apparatus shall have two clamps of at least 50 mm in width. Each clamp shall be designed to grip the test piece firmly, but without damage, along a straight line across the full width of the test piece (the clamping line) and shall have means for adjusting the clamping force.

The clamps should preferably grip the test piece between a cylindrical and a flat surface, with the plane of the test piece tangential to the cylindrical surface. Other types of clamps may be used if it can be ensured that the test piece does not slip or suffer any damage during the test.

During the test, the clamping lines shall be parallel to each other. They shall also be perpendicular to the direction of the applied tensile force and to the long dimension of the test piece.

The distance between the clamping lines (the test span length) shall be (100 ± 1) mm, except that a test span length of (50 ± 1) mm shall be used for finished paper products, of which one or both of the dimensions is insufficient to provide a test piece of the length required in 7.2.

NOTE Finished toilet-tissue sheets having one or both dimensions of about 98 mm is an example of such a material.

5.2 Cutting device

The cutting device shall meet the requirements of ISO 536 and shall produce test pieces (50,0 ± 0,5) mm wide, with undamaged, straight, smooth and parallel edges.

6 Conditioning

Condition the samples in a standard atmosphere at (23 ± 1) °C and (50 ± 2) % relative humidity according to ISO 187, unless otherwise agreed between the parties concerned.

7 Preparation of test pieces

7.1 General

The sample shall be selected in accordance with ISO 186.

Condition the samples as required in Clause 6 prior to cutting the test pieces, and keep them in the standard atmosphere throughout the test.

7.2 Dimensions

Each test piece shall be (50 ± 0,5) mm in width and at least 150 mm in length, avoiding perforations and faults. With the exception of tissue paper or tissue products having an embossed pattern all over or over part of the surface, the test pieces shall be free of creases, kinks, wrinkles, folds or other thickness variations.

For ready-to-use products having dimensions or perforations which make cutting of a test piece of at least 150 mm impossible, cut the longest piece possible. In such cases, a test span length of (50 ± 1) mm for the tensile-tester clamps (5.1.2) shall be used. This deviation from the normal procedure shall be recorded in the test report.

7.3 Number of test pieces

Take ten specimens from each sample of tissue product. From each specimen, cut one test piece in the machine direction, and one test piece in the cross direction, making a total of 20 test pieces from each sample of tissue paper or tissue product. Should, in isolated cases, the requisite number of ten test pieces in each direction not be available, test at least ten test pieces from the available specimens.

8 Procedure

Ensure that the tensile-testing apparatus is calibrated and check the zero position of the recording device.

Place the test piece in the clamps so that any observable slack is eliminated, but the test piece is not placed under any significant strain.

Do not touch the test area of the test piece between the clamps with the fingers. Align and tightly clamp the test piece and carry out the test.

Test 20 test pieces from each sample (7.3).

The elongation rate between the clamps shall be kept constant at (50 ± 2) mm/min (see 5.1).

Record all readings, except for test pieces that break within 5 mm from the clamping line. The latter case shall be subject to the following provision:

If more than 20 % of the test pieces cut from a particular specimen break within 5 mm from the clamping line, reject all the readings obtained for that specimen. Inspect the apparatus for conformity with the specifications and take the appropriate remedial measures.

9 Calculation

Calculate and report the results separately for the machine direction and for the cross direction from Equations (1) to (6).

9.1 Tensile strength

Calculate the mean maximum tensile force ($\overline{F}$), in newtons, from all the single values (F) available representing acceptable test results. Calculate the mean tensile strength ($\overline{S}$) from Equation (1):

$$\overline{S} = \frac{\overline{F}}{w_x} \times 10^3 \qquad (1)$$

where

$\overline{S}$ is the mean tensile strength, in newtons per metre;

$\overline{F}$ is the mean maximum tensile force, in newtons;

w_x is the initial width, in millimetres, of the test piece (standard 50 mm).

Report the tensile strength, in newtons per metre, to three significant figures.

9.2 Tensile index

Calculate the tensile index, I, from Equation (2):

$$I = \frac{\overline{S}}{g} \tag{2}$$

where

I is the tensile index, in newton metres per gram;

$\overline{S}$ is the mean tensile strength, in newtons per metre;

g is the grammage, in grams per square metre, determined in accordance with ISO 12625-6.

Report the tensile index, in newton metres per gram, to three significant figures.

9.3 Stretch at break

Calculate the mean elongation at break corresponding to the stretch of the test piece at break. Calculate the stretch at break A from Equation (3).

$$A = \frac{\varepsilon}{L} \times 100 \tag{3}$$

where

A is the mean stretch at break, in percentage;

ε is the mean elongation at break, in millimetres;

L is the length of the test piece between the clamps, before elongation (see 5.1.2), in millimetres.

Report the result to the first decimal place.

9.4 Tensile energy absorption

Determine the area under the force-elongation curve up to the point of maximum tensile force, and calculate the tensile energy absorption, Z, from Equation (4):

$$Z = \frac{E}{w_x \times l_x} \times 1000 \tag{4}$$

and the mean tensile energy absorption $\overline{Z}$ from Equation (5):

$$\overline{Z} = \frac{\sum Z}{n} \tag{5}$$

where

Z is the tensile energy absorption by a single test piece during the test until break, in joules per square metre;

$\overline{Z}$ is the mean tensile energy absorption, in joules per square metre;