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Textile fibres — Determination of breaking force and elongation at break of individual fibres

Fibres textiles — Détermination de la force de rupture et de l'allongement de rupture des fibres individuelles

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is Technical Committee *[or Project Committee]* ISO/TC *38*, *Textiles*, Subcommittee SC 23, *Fibres and yarns*.

This third edition cancels and replaces the second edition (ISO 5079:1995), which has been technically revised.

The main changes compared to the previous edition are as follows:

— xxx xxxxxxx xxx xxxx

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Textile fibres — Determination of breaking force and elongation at break of individual fibres

1 Scope

This document specifies the method and conditions of test for the determination of the breaking force and elongation at break of individual fibres in the conditioned or wet state.

The determination of these fibre properties, when carried out on different kinds of testing equipment, will not generally give identical results. To avoid such differences, this document is restricted to the use of constant-rate-of-extension testing apparatus.

It is applicable to all fibres, including crimped fibres, provided that the length of fibre available enables the gauge length specified in this document to be used.

NOTE For natural fibres (especially wool and cotton) the breaking test most commonly performed is that of bundles of fibres (see ISO 3060 and IWTO 32-82)

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 139, *Textiles — Standard atmospheres for conditioning and testing*

ISO 1130, *Textile fibres — Some methods of sampling for testing*

ISO 1973, *Textile fibres — Determination of linear density — Gravimetric method and vibroscope method*

ISO 2602, *Statistical interpretation of test results — Estimation of the mean — Confidence interval*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

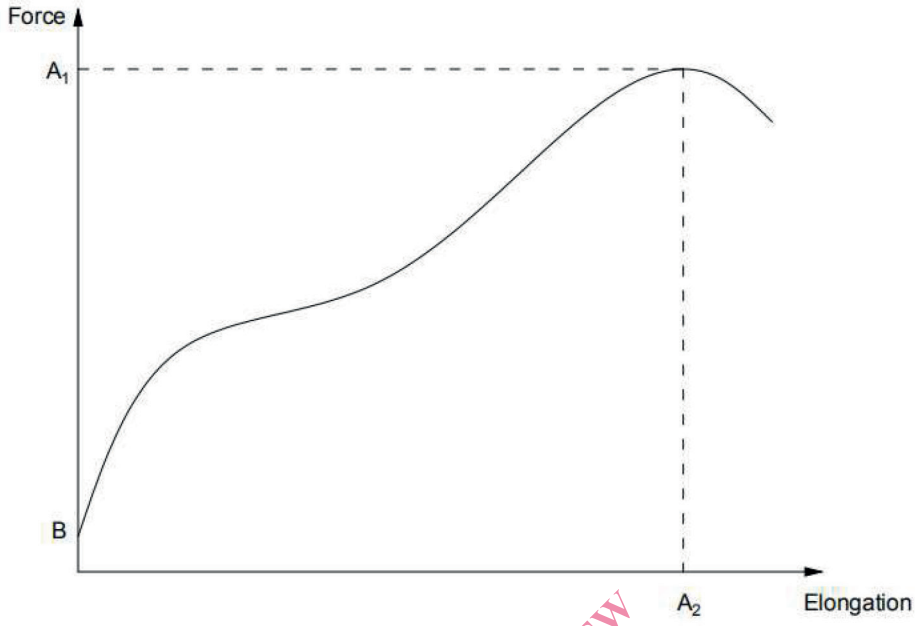
ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
breaking force
maximum force applied to a test specimen carried to rupture during a tensile test under specified conditions

Note 1 to entry: See A_1 in figure 1.



Key

A_1 breaking force

A_2 elongation at break

B pretension

Figure 1 — Typical force/elongation curve

3.2
extension
increase in length of a test specimen, produced by a force on that specimen, expressed in units of length

3.3
elongation
ratio of the extension of a test specimen to its initial length, expressed as a percentage

3.4
elongation at break
elongation of a test specimen produced by the breaking force

Note 1 to entry: See A_2 in figure 1.

3.5
gauge length
distance between the two effective clamping points of a testing device at the time of completing specimen insertion

Note 1 to entry: With guide groove or wrap bollard clamps, it is the distance between their gripping points, measured along the path of the specimen.

3.6
initial length
length of a test specimen(between the two effective clamping points) under specified pretension at the beginning of a test

3.7
pretension
tension applied to a test specimen at the beginning of a tensile test

3.8
breaking tenacity
breaking force divided by the linear density

4 Principle

An individual fibre is extended at a constant rate until rupture occurs.The breaking force and elongation at break are recorded.

If required, calculate the breaking tenacity, the linear density of the individual fibres or the mean linear density of the laboratory sample is also required (see ISO 1973).

5 Apparatus and reagents

5.1 Tensile testing machine

5.1.1 The machine shall be equipped with suitable clamps for gripping individual fibres at the required gauge length, a means for stretching the fibre to rupture at constant rate of extension by moving one of the clamps, and a means for recording the extension(elongation) of the fibre and the corresponding force.

A device giving a force/extension (tenacity/elongation) curve to indicate whether fibre slippage is occurring in the clamps is useful. A digital display or data-collecting system may be used in addition. Advice on mounting of test specimens is given in annex A.

5.1.2 The machine shall be capable of operating at various constant rates of extension between at least 5 mm/min and 40 mm/min.

5.1.3 The machine shall meet the following requirements of accuracy and repeatability.

a) The error in indication of the force shall not exceed ±1 % of the mean breaking force of the specimen.

b) The error in indication of the extension shall not exceed±0,1 mm.

c) The error of the gauge length shall not exceed ±0,2 mm. The constant rate of displacement of the moving clamp shall vary by less than ±5 %.

5.1.4 The clamps of the machine shall be capable of adjustment, and the surface of the clamp jaws in contact with the specimen shall be of a material to provide the correct gripping force without damage to the fibre, thereby avoiding slippage and jaw breaks (see 8.7).

5.2 Tweezers.

5.3 Distilled or deionized water

It is at a temperature of (20±2)°C, to which has been added a nonionic wetting agent to a maximum concentration of 0,1%, for use if wet testing is to be carried out.

6 Conditioning and testing atmospheres

The atmospheres for preconditioning, conditioning and testing shall be as specified in ISO 139.

7 Sampling and preparation of test specimen

To ensure that the laboratory sample is representative of the material and that the test specimen taken from the laboratory sample is representative of that sample, sampling shall be carried out in accordance

with ISO 1130. The effective part of the fibre under test shall not be damaged during preparing the test specimen.

For the staple fibers, the length shall be sufficient to allow gauge length.

For the filaments, cut into short fibers to allow an gauge length of 20 mm. Carefully remove the required number of single-fibres from the short fibres by grasping single-fibre at one end with tweezers. The effective part of the fibre under test shall not be damaged during preparing the test specimen.

8 Procedure

8.1 Condition the test specimens and carry out the tests in the standard atmosphere as specified in clause 6.

8.2 Adjust the machine to extend the test specimen using a speed of the moving clamp of

a) 50% gauge length per minute, for test specimens with a mean elongation at break lower than 8%,

b) 100% gauge length per minute, for test specimens with a mean elongation at break equal to or greater than 8% and lower than 50%,

or

c) 200% gauge length per minute, for test specimens with a mean elongation at break equal to or greater than 50%.

NOTE 1 In case of fibres with extreme high-extension or low-extension, different rates of extension are permitted upon agreement by the interested parties.

If the nominal elongation at break is not known, establish an approximate value by preliminary tests. In cases where the breaking elongation found in the preliminary test lies around 8% or 50%, one of the above testing speeds shall be agreed upon by the interested parties.

NOTE 2 If the final results vary slightly from those obtained in the preliminary test, a repetition of the test at a different speed is not necessary.

If both linear density and breaking force for the same fibre are required, then the linear density of the fibre shall be determined in accordance with ISO 1973 before the tensile test is performed.

8.3 The pretension used for the tensile test in the conditioned or wet state is specified as follow:

a) In the conditioned tests of staple fibers, use a pretension of (0,10±0,01) cN/dtex. For the fibres listed in Table 1, use the pretension values indicated.

Table 1 — Pretension forces for the conditioned test of staple fibers

Fibre	**Pretension**1) cN/dtex
Cellulose man-made fibres	0,060±0,006
Polyester fibres linear density<2 dtex linear density≥2 dtex	0,20±0,02 0,10±0,01
Meta-aramid fibres and polylactide fibres	0,12±0,03
Polyimide fibres	0,15±0,03
1) A higher pretension, e.g. to remove crimp, may be applied subject to agreement between the interested parties.	

b) In the conditioned tests of filaments, use a pretension of (0,050±0,005) cN/dtex.

c) In the wet tests of staple fibers and filaments, use a pretension of (0,025±0,003) cN/dtex for cellulose man-made fibres, and use a pretension which is half of that specified in the conditioned test for other fibres.

Calculate the mass necessary to obtain the required pretension on the basis of the nominal linear density of the fibre.

8.4 Use an gauge length of 20 mm.

NOTE Where it is impossible to use the 20 mm gauge length because of short fibre length, then an gauge length of 10 mm may be used. In this case the accuracy of results is reduced.

8.5 Prepare and mount an individual fibre (see Annex A) under specified pretension(see 8.3)in the clamps of the testing machine. For pretension, apply a mass piece to the fibre. Ensure that the fibre lies along the axis of extension of the machine.

The specified pretension can be applied automatically by the tester before starting the test. The automatic application of pretension shall be agreed upon by the interested parties and noted in the test report.

8.6 Start the testing machine with the specified rate of extension, and extend the test specimen to rupture, recording the elongation of the fibre and the corresponding force.

8.7 Test at least 50 fibres, unless otherwise agreed by the interested parties.

Record the number of fibre slippages and jaw breaks (e.g. breaks at the edge of or in the jaws). The condition of the clamps shall be such that the number of fibre slippages and jaw breaks does not exceed 20% of the number of specimens tested, otherwise the jaws shall be examined and, if necessary, changed.

Ascertain during the test that the clamped fibre length is not spuriously increased by slippage of the fibre in the jaws. This shall be done by inspection of the recorded curve or the recorded force and corresponding elongation.

Results obtained from test specimens showing jaw breaks or fibre slippages in the jaws shall be discarded.

NOTE If certain filaments with relatively high tenacity are normally impossible to be tested by the above method due to the occurrence of serious fibre slippage, it is recommended to use the tensile method given in Annex B.

8.8 If a wet test is required, first immerse the test specimens for a period of 2 min in distilled or deionized water (5.3).

With the lower clamp open, mount the wetted test specimen under pretension in the upper clamp. Wet the test specimen again for 10 s using a glass vessel filled with water (5.3). Then remove the glass vessel, close the lower clamp, immerse the clamped test specimen and the lower clamp in the water by lifting the water-filled glass vessel, and start the test. Make sure that the surface of the water dose not touch the upper clamp.

9 Expression of results

The following results shall be calculated in accordance with ISO 2602 :

a) the mean breaking force of the fibres tested, expressed in centinewtons to three significant figures;

b) the mean elongation at break of the fibres tested, expressed in percent to two significant figures;

