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Textiles — Yarn from packages — Determination of linear density (mass per unit length) by the skein method

Textiles — Fils sur enroulements — Détermination de la masse linéique (masse par unité de longueur) par la méthode de l'écheveau

Reference number
ISO 2060:1994(E)

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.

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.

International Standard ISO 2060 was prepared by Technical Committee ISO/TC 38, *Textiles*, Subcommittee SC 5, *Yarn testing*.

This second edition cancels and replaces the first edition ISO 2060:1972, which has been technically revised.

Annexes A and B form an integral part of this International Standard. Annexes C, D and E are for information only.

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Textiles — Yarn from packages — Determination of linear density (mass per unit length) by the skein method

1 Scope

This International Standard specifies a method for the determination of the linear density of all types of yarn in package form, with the exception of any yarn that may be the subject of a separate International Standard[1].

It includes seven optional procedures based on different methods of conditioning and preparation (see 4.1 and 4.2). Since the different procedures do not give the same values, it is essential that the procedure used is agreed by all parties interested in the test results.

While this method is designed solely for the determination of mass per unit length of yarn, it is frequently desirable to combine this determination with tests for strength and/or tests for commercial mass. If, in such a case, skein lengths other than those specified are used, the length used, and any special corrections based on it, are subject to agreement between the interested parties.

This method is applicable to

a) single yarns (spun, monofilament or multifilament);

b) folded (plied) yarns;

c) cabled yarns.

It is not applicable, except by agreement, to yarns which stretch more than 0,5 % when the tension, in centinewtons, per unit linear density of yarn, in tex, increases from 0,5 to 1,0. Such yarns may be tested under special conditions if they are accepted by all the parties interested in the test results.

The method is not applicable to yarns having a linear density greater than 2 000 tex. For such yarns, other skein lengths and special conditions of reeling may be adopted by agreement of the interested parties.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 139:1973, *Textiles — Standard atmospheres for conditioning and testing.*

ISO 1139:1973, *Textiles — Designation of yarns.*

ISO 1144:1973, *Textiles — Universal system for designating linear density (Tex System).*

ISO 1833:1977 and ISO 1833:1977/Amd.1:1980, *Textiles — Binary fibre mixtures — Quantitative chemical analysis.*

1) See also ISO 1889:1987, *Textile glass — Continuous filament yarns, staple fibre yarns, textured yarns and rovings (packages) — Determination of linear density* and ISO 10120:1991, *Carbon fibre — Determination of linear density*, which were prepared specially for the needs of textile glass technologies.

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 linear density: Mass per unit length of a yarn. It is expressed in tex or its multiples or submultiples. [see ISO 1139:1973 and ISO 1144:1973.]

3.2 commercial moisture regain: Arbitrary value formally adopted as the moisture regain to be used with the oven-dry mass when calculating

a) the linear density,

or

b) the commercial or legal mass of a shipment or lot (consignment) of any specific textile material.

3.3 commercial allowance: Arbitrary value equivalent to the commercial moisture regain plus an approved allowance for finish, formally adopted for use with the oven-dry mass when calculating

a) the linear density,

or

b) the commercial or legal mass of a shipment or delivery of any specific textile material.

3.4 moisture equilibrium: Condition reached by a sample at a closely defined temperature and relative humidity when the net difference between the amount of moisture absorbed and the amount desorbed, as indicated by a change in mass, shows no trend and becomes insignificant.

3.5 moisture equilibrium for testing: A textile material is in moisture equilibrium with the ambient atmosphere when it does not exchange water with this atmosphere; its mass then remains constant as long as the experiment is carried out in an unchanged atmosphere. For test purposes, moisture equilibrium is reached by absorption starting from a relatively low moisture content. Moisture equilibrium for testing is considered as having been reached when the rate of increase in mass of a sample or specimen due to moisture uptake does not exceed that prescribed for the material being tested (see ISO 139).

3.6 moisture-free mass

(1) Constant mass of a specimen obtained by drying material at a temperature of 105 °C ± 3 °C in a current of dry air.

(2) Amount of dry substance calculated from independent determination of moisture content, for example, distillation with an immiscible solvent or titration with Karl Fischer reagent (see also 3.7).

3.7 oven-dry mass: Constant mass of a specimen obtained by drying in an oven under prescribed conditions of temperature and humidity.

NOTE 1 Conditions most frequently used are a temperature of 105 °C ± 3 °C and an air supply having a relative humidity of 65 % at 20 °C, under which conditions the specimens will not be moisture-free.

3.8 yarn package: Length or lengths of yarn in a form suitable for use, handling, storing or shipping. Packages may be unsupported, such as balls, skeins or cakes, or supported, such as bobbins, cops, cones, pirns, spools, tubes or beams.

3.9 test skein; lea skein; numbering skein: Small skein which has a prescribed length of yarn and is used in this International Standard for the determination of linear density or breaking load, or both.

4 Principle

The linear density is calculated from the length and mass of suitable specimens. Specimens of suitable length are prepared by reeling test skeins for yarn numbering under specified conditions from samples that have been adequately conditioned after suitable preconditioning in skein form. In practice, the mass of the skeins is determined under various conditions, as noted in 4.1.1 to 4.1.3 and 4.2.1 to 4.2.4.

Any one of the options given in 4.1 and 4.2 may be used if mutually agreed.

4.1 Unscoured yarn

4.1.1 Option 1: mass of the conditioned yarn at equilibrium with the standard atmosphere for testing (see 11.3.1).

4.1.2 Option 2: mass of the oven-dry yarn (see 11.3.2).

4.1.3 Option 3: mass of the oven-dry yarn plus the commercial moisture regain (see 11.3.3).

4.2 Scoured yarn

4.2.1 Option 4: mass of the scoured yarn at equilibrium with the standard atmosphere for testing (see 11.4.2).

4.2.2 Option 5: mass of the scoured oven-dry yarn (see 11.4.3).

4.2.3 Option 6: mass of the scoured oven-dry yarn, plus the commercial moisture regain (see 11.4.4).

4.2.4 Option 7: mass of the scoured oven-dry yarn, plus the commercial allowances (see 11.4.5).

NOTE 2 The use of Option 1, 3 or 7 is recommended.

5 Apparatus

5.1 Reel, having a perimeter such that the required length of yarn is given by a whole number of revolutions, and with a traversing device that will avoid bunching of the yarn during reeling. A perimeter of 1,000 m ± 2,5 mm is recommended.

The reel shall be either

a) fitted with a positive feed system at a controlled tension of 0,5 ± 0,1 cN/tex, or

b) fitted with an adjustable tension device. In this case, the length of the skein may be checked by some suitable means (see annex A).

Variations in the specified length of the perimeter shall be small enough that skeins prepared on the reel conform with the specifications given in annex A.

NOTE 3 Existing reels with perimeters other than 1 m may be used if mutually agreed by the interested parties.

5.2 Ventilated drying oven, in which the yarn specimens are exposed at a temperature maintained at 105 °C ± 3 °C. The specimens shall not be subject to direct radiation from the heating units. The oven shall be supplied with a current of predried air (less than 0,01 g of water per 1 000 l) at such a rate that the volume of air in the oven will be renewed at least once every 4 min. Alternatively, by agreement of all interested parties, the oven may be supplied with air at any specified temperature and relative humidity (R.H.). The oven shall be designed to facilitate the free passage of air through the specimens. The oven may be provided with facilities for cutting off the air current and weighing the specimens without their removal from the oven.

NOTE 4 Air under standard temperature conditions (65 % R.H. at 20 °C) has a moisture vapour pressure of 1 515 Pa. If the temperature of this air is raised to 105 °C, the air will have a relative humidity of 1,25 %. Under these conditions, samples of textiles with a high moisture regain, such as regenerated cellulose or wool, may retain up to 0,5 % moisture. Accurate results can be secured only by suppling predried air to the oven. However, results of equal precision (but at somewhat lower levels of observed moisture content) may be obtained by supplying upper limits of temperature and humidity.

5.3 Balance, having an appropriate capacity and a sensitivity equal to 1 part in 1,000 of the mass of the skein or skeins to be weighed. (These tolerances apply to the balance used, whether or not it is combined with the oven.)

5.4 Auxiliary equipment suited to the samples and procedures to be used, including conventional sample supports, weighing bottles with ground glass stoppers, tared wire gauze weighing baskets of noncorrodible metal, etc.

5.5 Facilities for scouring or extracting samples, if required (see annex C).

6 Standard atmospheres

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

NOTE 5 Air at 20 °C and 65 % R.H. has a water vapour pressure of 1 515 Pa and when heated to 47 °C ± 3 °C will produce an atmosphere having a relative humidity of 12,3 % to 16,7 %. Air at the maximum limit of 22 °C and 67 % R.H. has a water vapour pressure of 1 770 Pa which, heated to 44 °C to 50 °C, results in humidities in the range of 14,3 % to 19,4 %. Any departure from the standard preconditioning atmosphere should be agreed by the interested parties and the temperature and humidity used stated in the test report.

7 Sampling

7.1 Sampling shall be carried out in one of the following ways:

a) according to directions, if any, given in the material specification;

b) according to procedures approved by ISO for textile products, if directions on sampling are not included in the material specification;

c) according to the method given in annex B.

7.2 The bulk sample shall be taken in such a manner that it is representative of the lot (consignment) to be tested (see annex B).

7.3 One laboratory sample skein shall be reeled from each laboratory sample package. The skeins shall be long enough to provide yarn for all tests re-

quired. In reeling the skeins, the yarn shall be taken from the end of the package if this is the normal method of use; otherwise the yarn shall be taken from the side of the package. The few metres of yarns at the beginning and end of the package shall be discarded in order to avoid damaged sections.

8 Preconditioning and conditioning

Carry out preconditioning and conditioning of the laboratory sample skeins as specified in 8.1 and 8.2.

8.1 Precondition the laboratory sample skeins by exposing them to freely moving air in the specified atmosphere for preconditioning (see clause 6) for a minimum of 4 h.

Samples shall not be oven-dried during preconditioning. Even though the term "preconditioning" is frequently translated as "predrying", only partial drying is needed.

8.2 After preconditioning the laboratory sample skeins as specified in 8.1, bring them to moisture equilibrium for testing by exposing them to the appropriate standard atmosphere for testing for 24 h or until there is no progressive change in mass greater than 0,1 % in successive exposures of at least 30 min duration (see also annex D).

9 Test specimens

9.1 Length

9.1.1 Test skeins for measurement of linear density shall be of the following lengths whether the yarn is single, folded, multiplied or cabled:

a) 200 m for yarns having a linear density below 12,5 tex;

b) 100 m for yarns having a linear density from 12,5 to 100 tex;

c) 10 m for yarns having a linear density of more than 100 tex.

NOTES

6 Tolerances for skein lengths are given in annex A.

7 In the case of folded and cabled yarns, the limit stated applies to the linear density of the resultant yarn.

9.1.2 If it is desired to combine the determination of linear density as described in this International Standard with the determination of other properties, for example skein strength or commercial mass, the lengths specified in 9.1.1 shall be used as far as possible. When shorter lengths are required for strength tests, additional skeins shall be reeled to secure the lengths required in this method; for example, two 50 m skeins for a required 100 m length. Additional skeins of the length specified may be taken for other purposes as required.

9.2 Number

Test the number of specimens required in the material specification when applicable; otherwise, test one specimen from each laboratory sample skein.

10 Preparation of specimens (test skeins) for yarn numbering

10.1 Mount the conditioned laboratory sample skeins, prepared as specified in clause 7, on a swift or other equipment to facilitate rotation.

10.2 Using a winding tension described in 5.1, prepare a test skein, or skeins, by reeling the required number of turns to secure the length needed. When reeling a skein, traverse the specimen over the full width permitted by the reel to reduce the superposition of the second layers of yarn on the first layer of the reel. Cut the test skein free from the laboratory sample skein, tie the ends of the skein together and cut the loose ends short (less than 2,5 cm). Remove the test skein from the reel for weighing.

NOTE 8 In the event of dispute of skein length, a skein gauge or other mutually agreeable means should be used (see annex A).

10.3 Repeat the procedure given in 10.2 to obtain the required number of skeins.

10.4 If the test skein is to be used for the determination of yarn strength by either the single-strand or skein test, collapse one or more arms of the reels before removing the skein.

11 Procedure and calculations

11.1 Units

For all options, determine the linear density in units of the Tex System (see ISO 1144). Round off calcu-

lated values and report them to three significant figures.

NOTE 9 Factors for converting units of the Tex System to other units in common use are given in annex E.

11.2 Variability of observations

If desired, calculate the coefficient of variation of the observed values of linear density by recognized statistical methods but base the calculation on at least 20 specimens. Rounding of the mean values shall be reported, taking into account the accuracy of the individual length and mass measurements.

NOTE 10 The coefficient of variation of linear density of a yarn decreases as skein length increases. The coefficients of variation calculated according to this method will accordingly be comparable only to other coefficients of variation calculated from the specified skein lengths.

11.3 Unscoured specimens

11.3.1 Option 1: mass of conditioned yarn at equilibrium with the standard atmosphere for testing (see 4.1.1).

11.3.1.1 Weigh each conditioned test skein (see clause 9) on a suitable balance (5.3), in grams, in the appropriate standard atmosphere for testing (see clause 6). (See note 11.)

11.3.1.2 Calculate the linear density Tt_c, expressed in tex, from the mass and length of the conditioned skein according to the equation:

$$Tt_c = \frac{m_c \times 10^3}{L}$$

where

m_c is the mass, in grams, of the conditioned test skein;

L is the length, in metres, of the numbering skein.

NOTE 11 In cases where information on the variation in linear density is not wanted and only an average value is desired, groups of two or more skeins may be weighed at one time.

11.3.2 Option 2: mass of oven-dry yarn (see 4.1.2).

11.3.2.1 Place the conditioned specimen (see clause 10) in the oven (5.2) maintained at 105 °C ± 3 °C. Arrange the specimen in a wire basket or other comparable container (see 5.4) to permit free access of air to the specimen in the oven.

11.3.2.2 Dry the skein to constant mass, which shall be considered as attained when no progressive change in mass greater than 0,1 % occurs in successive weighings spaced by a drying period of

a) at least 20 min if the specimen has not been removed from the oven,

or

b) at least 40 min if the specimen has been removed and cooled for weighing outside the oven.

11.3.2.3 Obtain the mass, in grams, of the oven-dry specimen to the precision required, in accordance with 11.3.2.3.1 or 11.3.2.3.2.

11.3.2.3.1 If the specimen is to be weighed in the oven, stop the air flow through the oven and weigh the specimen (see note 11).

11.3.2.3.2 If the specimen is not to be weighed in the oven, transfer the basket with the specimen to a suitable tared weighing can or bottle. Close the container immediately and place it in a desiccator to cool. While the specimen is cooling, periodically loosen the container cover momentarily to permit equalization of air pressure, re-cover tightly and weigh when cool (see note 11).

11.3.2.4 Calculate the linear density Tt_{od}, expressed in tex, of the oven-dry yarn according to the equation:

$$Tt_{od} = \frac{m_{od} \times 10^3}{L}$$

where

m_{od} is the mass, in grams, of the oven-dry test specimen;

L is the length, in metres, of the test specimen.

11.3.3 Option 3: mass of the oven-dry yarn plus commercial moisture regain (see 4.1.3).

11.3.3.1 Dry and weigh the test skeins as directed for Option 2 in 11.3.2.1 to 11.3.2.3.

11.3.3.2 Calculate the linear density of the yarn Tt_{pr}, expressed in tex, according to the equation:

$$Tt_{pr} = \frac{Tt_{od}(100 + R)}{100}$$

where

R is the commercial moisture regain, in percent, for the fibre being tested;

Tt_{od} is as defined in 11.3.2.4.

11.3.3.3 If the sample comprises two or more fibre types that have different commercial moisture regains, calculate the commercial moisture regain from the proportions of the different fibres that are known or determined from analysis (see ISO 1833) to be present in the yarn, as follows:

$$R = \frac{(P_A \times R_A) + (P_B \times R_B) + \ldots}{100}$$

where

R is the total commercial moisture regain, expressed as a percentage based on dry mass, of a yarn comprised of fibres A, B, etc.;

P_A, P_B, ... are the respective percentages of fibres A, B, etc. comprising the yarn;

R_A, R_B, ... are the respective commercial moisture regains, expressed as percentages, of fibres A, B, etc. comprising the yarn.

For example, if a yarn contains 20 % of secondary acetate staple with a commercial moisture regain of 6,5 %, and 80 % of wool with a commercial moisture regain of 15 %, the total commercial moisture regain will be:

$(0{,}20 \times 6{,}5\ \%) + (0{,}80 \times 15\ \%) =$

$1{,}3\ \% + 12{,}0\ \% = 13{,}3\ \%$

11.3.3.4 If the specimen includes one or more fibre types for which no commercial moisture regain has been established, a suitable value must be agreed upon by the interested parties.

11.4 Scoured specimens

11.4.1 Preparation

The test skeins shall be subjected to a boil-off or extraction procedure agreed to by the interested parties. A suggested procedure for boiling off test skeins is given in annex B.

11.4.2 Option 4: mass of the scoured yarn at equilibrium with the standard atmosphere for testing (see 4.2.1).

11.4.2.1 After the scouring operation is complete, allow the test skeins for yarn numbering to dry in the ambient atmosphere, precondition them as described in 8.1 and bring them to equilibrium for testing in the appropriate standard atmosphere for testing as described in 8.2.

11.4.2.2 Weigh the conditioned test skeins as directed in 11.3.1.1 and calculate the linear density as directed in 11.3.1.2.

11.4.3 Option 5: mass of scoured oven-dry yarn (see 4.2.2).

11.4.3.1 Dry and weigh the scoured test skeins as directed for Option 2 in 11.3.2.1 to 11.3.2.3.

11.4.3.2 Calculate the linear density of the oven-dry yarn as directed for Option 2 in 11.3.2.4.

11.4.4 Option 6: mass of the scoured oven-dry yarn plus the commercial moisture regain (see 4.2.3).

11.4.4.1 Dry and weigh the scoured test skeins as directed for Option 2 in 11.3.2.1 to 11.3.2.3.

11.4.4.2 Calculate the linear density as directed for Option 3 in 11.3.3.2 to 11.3.3.4.

11.4.5 Option 7: mass of the scoured oven-dry yarn plus the commercial allowance (see 4.2.4).

11.4.5.1 Dry and weigh the scoured test skeins as directed for Option 2 in 11.3.2.1 to 11.3.2.3.

11.4.5.2 Calculate the linear density Tt_{sod}, expressed in tex, of scoured oven-dry yarn with commercial allowance using the equation

$$Tt_{sod} = \frac{Tt_{od}(100 + K)}{100}$$

where

K is the commercial allowance, in percent, for the fibre being tested;

Tt_{od} is as defined in 11.3.2.4.

11.4.5.3 If the test skein comprises two or more fibre types that have different commercial allowances, calculate the overall factor from the proportions of the different fibres that are known, or determined from analysis (see ISO 1833), to be present in the yarn as follows:

$$K = \frac{(P_A \times K_A) + (P_B \times K_B) + \ldots}{100}$$

where

K is the overall commercial allowance, expressed as a percentage based on dry mass, of a yarn comprised of fibres A, B, etc.;

P_A, P_B, ... are the respective percentages of fibres A, B, etc. comprising the yarn;

K_A, K_B, ... are the respective commercial allowances, expressed as percentages, of fibres A, B, etc. comprising the yarn.

For example, if a yarn contains 20 % of secondary acetate staple with a commercial allowance of 9,0 % and 80 % of viscose with a commercial allowance of 13 %, the overall commercial allowance will be

$$(0{,}20 \times 9{,}0\ \%) + (0{,}80 \times 13\ \%) =$$

$$1{,}8\ \% + 10{,}4\ \% = 12{,}2\ \%$$

11.4.5.4 If the test skein includes one or more fibre types for which no commercial allowance has been established, a suitable value must be agreed upon the interested parties.

12 Test report

The test report shall contain the following information:

a) the number and year of publication of this International Standard, i.e. ISO 2060:1994;

b) sufficient information for complete identification of the sample tested;

c) the mean linear density in units of the Tex System;

d) the number of test specimens;

e) the length of yarn in each test skein;

f) the coefficient of variation of the linear density, if determined;

g) the option used, specifying the commercial moisture regain or commercial allowance used, where applicable;

h) the sampling scheme employed;

i) the temperature and relative humidity of the air supplied to the drying oven;

j) any deviation, by agreement or otherwise, from the procedure specified.