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

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FOREWORD

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Australia	Hungary	South Africa, Rep. of
Belgium	India	Sweden
Canada	Israel	Switzerland
Czechoslovakia	Japan	Turkey
Denmark	Netherlands	United Kingdom
Egypt, Arab Rep. of	Norway	U.S.A.
Finland	Poland	U.S.S.R.
France	Portugal	
Germany	Romania	

No Member Body expressed disapproval of the document.

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Textiles – Yarn from packages – Determination of linear density (mass per unit length) – 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 and different recommended allowances. (See 5.1 and 5.2.) Since the different procedures do not give the same values, it is essential that the procedure to be used is accepted 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 case, skein lengths other than those specified are used, the length used, and any special corrections based on it, must be accepted by all parties interested in the test results.

2 FIELD OF APPLICATION

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 the 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 all parties interested in the test results.

3 REFERENCES

ISO/R 139, *Standard atmospheres for conditioning and testing textiles.*

ISO/R 1139, *Textiles – Designation of yarns.*

ISO/R 1144, *Textiles – Universal system for designating linear density (Tex system).*

ISO/R 1833, *Textiles – Binary fibre mixtures – Quantitative chemical analysis.*

4 DEFINITIONS

4.1 linear density : Mass per unit length of a yarn. It is expressed in tex or its multiples or sub-multiples. (See ISO/R 1139 and ISO/R 1144.)

4.2 commercial moisture regain : An arbitrary value formally adopted as the regain to be used with the oven-dry mass when calculating

1) the linear density, or

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

4.3 commercial allowance : An 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

1) the linear density, or

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

4.4 moisture equilibrium : The 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.

1) See also ISO/R 1889, *Textile glass – Determination of the linear density of textile glass continuous filament yarns, staple fibre yarns and rovings in the form of packages,* which was prepared specially for the needs of the glass textile technology.

4.5 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 must be 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 does not exceed that prescribed for the material being tested. (See ISO/R 139.)

4.6 moisture-free mass :

4.6.1 The constant mass of a specimen obtained by drying material at a temperature of 105 ± 3 °C in a current of desiccated air.

4.6.2 The amount of dry substance calculated from independent determinations of moisture content, for example, by distillation with an immiscible solvent or by titration with Fischer reagent. (See also oven-dry mass.)

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

NOTE – Conditions frequently used are a temperature of 105 ± 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.

4.8 yarn package : A 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.

4.9 test skein : A 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; also called a lea skein or numbering skein.

5 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 5.1.1 to 5.1.3 and 5.2.1 to 5.2.4.

Any one of the following options may be used if mutually agreed :

5.1 Basis of unscoured yarn

5.1.1 *Option 1* : The mass of the conditioned yarn at equilibrium with the standard atmosphere for testing (see 11.1.2).

5.1.2 *Option 2* : The mass of the oven-dry yarn (see 11.1.3).

5.1.3 *Option 3* : The mass of the oven-dry yarn plus the commercial moisture regain (see 11.1.4).

5.2 Basis of scoured yarn

5.2.1 *Option 4* : The mass of the scoured yarn at equilibrium with the standard atmosphere for testing (see 11.2.2).

5.2.2 *Option 5* : The mass of the scoured oven-dry yarn (see 11.2.3).

5.2.3 *Option 6* : The mass of the scoured oven-dry yarn plus the commercial moisture regain (see 11.2.4).

5.2.4 *Option 7* : The mass of the scoured oven-dry yarn, plus the commercial allowance (see 11.2.5).

6 APPARATUS

6.1 Facilities for producing and maintaining the standard atmosphere for testing in the test laboratory (see 7.1).

6.2 Facilities for producing and maintaining the special atmosphere for preconditioning (see 7.2).

6.3 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 is recommended.

The reel shall be either

a) circular and fitted with a positive feed system at a controlled tension of 0.5 ± 0.1 cN/unit of nominal yarn linear density in tex, or

b) fitted with an adjustable tension device, in which case the length of the skein shall be checked by some suitable means, for example, a skein gauge. (See 6.4 and Appendix Y.)

Variations in the specified length of the perimeter shall be small enough that skeins prepared on the reel will conform with the specifications given in 6.4.

NOTE – Existing reels with perimeters other than 1 m may be used if mutually agreed.

6.4 Means for checking the accuracy of the length of the yarn numbering test skein, under a load per end equal to 0.5 ± 0.1 cN per unit of nominal yarn linear density, expressed in tex. (See Appendix Z.) The method used shall be sufficiently sensitive to permit rejection of skeins whose length falls outside the limits of ± 0.2 % of the length of the yarn expected from one turn of the reel, for example, 1.000 m.

6.5 Ventilated drying oven in which the yarn specimens are exposed at a temperature maintained at 105 ± 3 °C. The specimens shall not be subject to direct radiation from the heating units. The oven shall be supplied with a current of pre-dried air (less than 0.01 g of water per 1 000 litres) at such a rate that the volume of air in the oven will be supplied at least once every 4 min. Alternatively, by agreement of all parties interested in the test results, 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 the air through the specimens. The oven may be provided with facilities for cutting off the air current and weighing the specimens without removal from the oven.

NOTE — Air under standard temperate conditions (65 % R.H. at 20 °C) has a moisture vapour pressure of 1 515 N/m². 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 supplying predried air to the oven. However, results of equal precision (but at somewhat lower levels of observed moisture content) may be obtained by supplying the oven with any constant atmosphere having reasonable upper limits of temperature and humidity.

6.6 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.)

6.7 Auxiliary facilities 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 non-corrodible metal, etc.

6.8 Facilities for scouring or extracting samples, if required (see Appendix X).

7 STANDARD ATMOSPHERES

The standard atmospheres for conditioning and testing are those defined in ISO/R 139.

NOTE — Air at 20 °C and 65 % R.H. has a water vapour pressure of 1 515 N/m² and when heated to 47 ± 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 N/m² which, heated to 44 to 50 °C, results in humidities in the range of 14.3 to 19.4 %. If it is desired to keep the R.H. below 10 % and not to exceed a temperature of 50 °C, then the original air must have a water vapour pressure below 1 230 N/m² equivalent to 53 % R.H. at 20 °C or 30 % R.H. at 27 °C.

8 SAMPLES

8.1 Samples shall be taken 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 Appendix W, if neither a) nor b) is applicable.

8.2 The bulk sample shall be taken in such a manner that it is representative of the lot to be tested (see Appendix W).

8.3 One laboratory sample skein shall be reeled from each laboratory sample package. The skeins shall be long enough to provide yarn for all tests required. In reeling the skeins take the yarn, using the least tension practicable, from the end of the package if this is the normal method of use; otherwise take the yarn from the side of the package. Discard the few metres of yarn at the beginning and end of the package in order to avoid damaged sections.

8.4 Conditioning of the laboratory sample skeins shall be carried out as follows :

8.4.1 Precondition the laboratory sample skeins by exposing them to freely moving air in the special atmosphere for preconditioning (see section 7) for a minimum of 4 h. Samples must not be oven dried during preconditioning. Even though the term "preconditioning" is frequently translated as "predrying", only partial drying is desired.

8.4.2 After preconditioning the laboratory sample skeins as specified in 8.4.1, 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 Appendix Y).

9 SPECIMENS

9.1 Length

9.1.1 Test skeins for yarn numbering 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) 50 m for spun yarns having a linear density of more than 100 tex;

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

NOTE – In the case of folded and cabled yarns, the limiting linear density stated applies to the resultant yarn linear density.

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 prescribed above shall be used as far as possible. When shorter lengths are required for strength tests, reel additional skeins to secure the lengths required in this method, for example, two 50 m skeins for the 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 directed in section 8, on a swift or other equipment to facilitate easy rotation.

10.2 To establish the desired tension for reeling, reel a test skein from the conditioned laboratory sample skein by passing the free end of the yarn to be reeled through the traverse guide and through any required pre-tensioning unit. Fasten the free end of the yarn to an arm of the fly, and reel the required length (see 9.1.1) under a tension to be determined as described in 10.3.

10.3 The tolerance of reeling tension shall be such that the length of a test skein is within the nominal length ± 0.25 %. If necessary, adjust the pretensioning unit for reeling until the above conditions have been met.

10.4 Using the reeling tension determined as directed in 10.3, prepare a specimen numbering skein, or skeins, by reeling the required number of turns to secure the length desired. When reeling a skein, traverse the specimen over the full width permitted by the reel in order to reduce as far as possible the superposition of the second layer of yarn on the first layer on the reel. Cut the numbering skein free from the laboratory sample skein, tie the ends of the skein together and cut the loose ends off short (less than 2.5 cm). Remove the numbering skein from the reel for weighing.

10.5 Repeat the procedure given in 10.4 for the required number of skeins.

10.6 If the numbering skein is to be used for the determination of yarn strength by either the single strand or skein test, one or more arms of the reel must be collapsed before removing the skein.

11 PROCEDURE AND CALCULATIONS

11.1 Unscoured specimens

11.1.1 *Units*

For all options, the linear density shall be determined in units of the Tex System. Calculated values shall be rounded off and reported to three significant figures.

NOTE – Factors for converting units of the Tex System to other units in common use are given in Appendix V.

11.1.2 *Option 1*

Basis : mass of conditioned yarn at equilibrium with the standard atmosphere for testing (5.1.1).

11.1.2.1 Weigh each conditioned test skein (see section 10) on a suitable balance (6.6), in grams, in the appropriate standard atmosphere for testing (7.1). (See Note following 11.1.2.2.)

11.1.2.2 Calculate the linear density from the mass and length of the skein according to the following equation :

$$\text{Linear density of conditioned yarn, in tex units,} = \frac{\text{mass of conditioned numbering skein, in grams} \times 1\,000}{\text{length of numbering skein, in metres}}$$

NOTE – 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.

11.1.3 *Option 2*

Basis : mass of oven-dry yarn (5.1.2).

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

11.1.3.2 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.

11.1.3.3 Obtain the mass of the oven-dry specimen in grams, to the precision desired, as directed in 11.1.3.3.1 or 11.1.3.3.2 below.

11.1.3.3.1 If the specimen is to be weighed in the oven, stop the current of air through the oven and weigh the specimen (see Note following 11.1.2.2).

11.1.3.3.2 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 specimens are cooling, periodically loosen the container cover momentarily to permit equalization of air pressure, re-cover tightly and weigh when cool (see Note following 11.1.2.2).

11.1.3.4 Calculate the linear density of the oven-dry yarn according to the following equation :

Linear density of oven-dry yarn, in tex units,

$$= \frac{\text{mass of the oven-dry specimen, in grams} \times 1\,000}{\text{length of the specimen, in metres}}$$

11.1.4 *Option 3*

Basis : mass of the oven-dry yarn plus commercial moisture regain (5.1.3).

11.1.4.1 Dry and weigh the test skeins as directed for Option 2 in 11.1.3.1, 11.1.3.2 and 11.1.3.3.

11.1.4.2 Calculate the linear density of yarn according to the following equation :

Linear density at prescribed regain, in tex units,

$$= \frac{\text{linear density of oven-dry yarn} \times (100 + R)}{100}$$

where R is the commercial moisture regain for the fibre being tested, in per cent.

11.1.4.3 If the sample comprises two or more fibre types that have different commercial moisture regains, the indicated factor shall be calculated from the proportions of the different fibres that are known, or determined from analysis[1], to be present in the yarn, as follows :

Calculated commercial moisture regain of yarn comprised of fibres A and B (based on dry mass) etc.

$$= \frac{(\%\ \text{A} \times \text{commercial moisture regain of A})}{100} + \frac{(\%\ \text{B} \times \text{commercial moisture regain of B})}{100} + \text{etc.}$$

For example, assume that the 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 appropriate commercial moisture regain will be

$(0.20 \times 6.5\ \%) + (0.80 \times 15\ \%) = 1.3\ \% + 12.0\ \% = 13.3\ \%$

11.1.4.4 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 parties interested in the test results.

11.2 Scoured specimens

11.2.1 *Preparation*

The test skeins shall be subjected to a boil-off or extraction procedure which is agreeable to all parties interested in the test results. A suggested procedure for boiling off test skeins is given in Appendix X.

11.2.2 *Option 4*

Basis : mass of the scoured yarn at equilibrium with the standard atmosphere for testing (5.2.1).

11.2.2.1 After the scouring operation is complete, allow the test skeins for yarn numbering to dry in the ambient atmosphere, precondition them as described in 8.4.1 and bring them to equilibrium for testing in the standard atmosphere for testing as described in 8.4.2.

11.2.2.2 Weigh the conditioned test skeins as directed in 11.1.2.1 and calculate the linear density as directed in 11.1.2.2.

1) See ISO/R 1833.

11.2.3 *Option 5*

Basis : mass of scoured oven-dry yarn (5.2.2).

11.2.3.1 Dry and weigh the scoured test skeins as directed for Option 2 in 11.1.3.1, 11.1.3.2 and 11.1.3.3.

11.2.3.2 Calculate the linear density of the oven-dry yarn as directed in Option 2, 11.1.3.4.

11.2.4 *Option 6*

Basis : mass of the scoured oven-dry yarn with commercial moisture regain (5.2.3).

11.2.4.1 Dry and weigh the scoured test skeins as directed for Option 2 in 11.1.3.1, 11.1.3.2 and 11.1.3.3.

11.2.4.2 Calculate the linear density as directed for Option 3 in 11.1.4.2, 11.1.4.3 and 11.1.4.4.

11.2.5 *Option 7*

Basis : mass of the scoured oven-dry yarn with commercial allowance (5.2.4).

11.2.5.1 Dry and weigh the scoured test skeins as directed for Option 2 in 11.1.3.1, 11.1.3.2 and 11.1.3.3.

11.2.5.2 Calculate the linear density according to the following equation :

Linear density of scoured oven-dry yarn with commercial allowance in tex units,

$$= \frac{\text{linear density of oven-dry yarn} \times (100 + K)}{100}$$

where K is the commercial allowance for the fibre being tested, in per cent.

11.2.5.3 If the sample comprises two or more fibre types that have different commercial allowances, the indicated factor shall be calculated from the proportions of the different fibres that are known, or determined from analysis[1], to be present in the yarn as follows :

Calculated commercial allowance of yarn comprised of fibres A and B (based on dry mass) etc.

$$= \frac{(\%\ A \times \text{commercial allowance of A})}{100} + \frac{(\%\ B \times \text{commercial allowance of B})}{100} + \text{etc.}$$

For example, assume that the yarn contains 20 % of secondary acetate staple with a commercial allowance of 9.0 % and 80 % of rayon with a commercial allowance of 13 %; the appropriate commercial allowance will be

$(0.20 \times 9.0\ \%) + (0.80 \times 13\ \%) = 1.8\ \% + 10.4\ \% = 12.2\ \%$

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

11.2.6 *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 twenty specimens.

NOTE — The coefficient of variation of linear density of a yarn is affected by specimen length; it decreases as skein length increases. The coefficients of variation calculated in this method will accordingly be comparable only to other coefficients of variation calculated from the specified skein lengths.

12 TEST REPORT

The test report shall state that the tests were performed in accordance with this International Standard and shall indicate which of any alternative or optional requirements have been met.

In addition, it shall give the following information :

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

b) the number of test specimens;

c) the length of yarn in each test skein;

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

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

f) the sampling scheme employed.

1) See ISO/R 1833.

APPENDIX V

LINEAR DENSITY CONVERSION FACTORS (See ISO/R 1144)

The following factors may be used to convert linear density in tex units to linear density in other common systems :

a) For other direct yarn numbering systems :

tex units X 9.0 = denier units

tex units X 0.029 03 = spyndle units

b) For indirect yarn numbering systems :

1 000.0/tex units = metric number (metres per gram)

496 055.0/tex units = yards per pound

310.0/tex units = American woollen run number (100 yd runs)

1 938.0/tex units = woollen count (Yorkshire skeins 256 yd hanks)

590.5/tex units = English cotton number (840 yd hanks)

885.8/tex units = English worsted number (560 yd hanks)

1 654 /tex units = linen number (300 yd leas)

1 654/tex units = woollen number (300 yd cuts)

4 961/tex units = American asbestos number (100 yd hanks)

Note that numbers in other indirect units based on different yardages can be conveniently calculated on the basis of the relationship of their length to 100 yards.