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Silk — Test method for determining the size of silk yarns

Soie — Méthode d'essai pour déterminer le titre des fils de soie

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Contents

Page

Foreword

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This document was prepared by Technical Committee ISO/TC 38, *Textiles*, Subcommittee SC 23, *Fibres and yarns*.

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.

Introduction

Silk yarns are made of natural silk fibres, including raw silk, tussah silk, dupion silk, thrown silk, etc. Due to the intrinsic unevenness of the property of silk fibres and its manufacturing technique differing from yarns made of staple fibres, the size (linear density) deviation of the silk yarns, such as raw silk reeled from cocoon baves, is much bigger than that of the conventional yarns covered by ISO 2060. Therefore, when measuring the size of silk yarns, the sample quantity, sample length, test device, drying temperature, test items, calculation method of the results and tolerance for weighing errors are all different from that for the conventional yarns. These special requirements are not prescribed in ISO 2060. This document covers special size test regulations for silk yarns which are not covered by ISO 2060.

Silk — Test method for determining the size of silk yarns

1   Scope

This document specifies the test method for determining the size of silk yarns in all types of package forms.

It is applicable to various kinds of silk yarns.

It is not applicable to spun silk yarns.

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 6741-1:1989, *Textiles — Fibres and yarns — Determination of commercial mass of consignments — Part 1: Mass determination and calculations*

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
silk yarn
yarn made of nature silk fibres, including raw silk, tussah silk, dupion silk, thrown silk

3.2
thrown silk
silk that has been twisted or doubled and twisted

3.3
size
linear density (mass per unit length) of silk yarns

Note 1 to entry: Size expresses the degree of coarseness or fineness of silk yarns.

Note 2 to entry: Size is expressed in dtex. It may also be expressed in deniers (den), for which the conversion from dtex, as given in ISO 1144[1], is 1 den = 0,9 dtex.

3.4
nominal size
size indicated by the manufacturer

3.5
average size
average value of the tested size of the sizing skeins

3.6
conditioned size
size calculated by adding the commercial moisture regain weight to the oven-dry weight

Note 1 to entry: For silk, the commercial moisture regain is 11,0 %, which was developed in 1841, and then was widely used by Japan, China, India, etc. See Reference [4].

3.7
size deviation
standard deviation of the value of the tested size of the silk samples indicating the deviation degree of the sizing skeins from the average size of the whole lot

3.8
maximum size deviation
indication of the deviation degree of the finest sizing skeins or the coarsest sizing skeins from the average size of the whole lot

3.9
coefficient of variation of size
CV_{size}
percentage ratio between the size deviation and the average size

4   Principle

Under standard atmosphere, the sizing skeins are prepared by winding prescribed revolutions of silk yarn on a reel with a specified length of circumference from conditioned silk samples. The sizing skeins are weighed. The silk size is calculated from the length and mass, expressed in dtex (or den).

5   Apparatus

5.1   Wrap reel, with a reel circumference of (1 125 ± 2,5) mm, revolving at a constant speed of (300 ± 15) r/min to ensure a constant tension or fitted with a positive feed system at a controlled tension of (0,05 ± 0,01) cN/dtex, equipped with a dial showing the number of revolutions and an automatic stop-motion to stop the reel.

A reel circumference of (1 000 ± 2,5) mm may be used and reported in the test report (see Clause 9) if mutually agreed by the interested parties**.**

5.2   Size testing devices.

a)   For balance: resolution ≤0,001 g.

b)   For size tester: resolution ≤0,25 dtex (0,25 den).

5.3   Principle of size testing device.

The size testing device is a kind of balance with a built-in computing program which changes the weight of each sizing skein (test sample of a prescribed length) into size value according to the definition of size. The built-in program in the device can calculate and print out size distribution, size deviation, maximum size deviation and CV_{size} automatically.

5.4   Oven, as described in ISO 2060[2], in which the silk yarn samples are exposed at a temperature of 140 °C ± 2 °C.

6 Atmosphere for conditioning and testing

Atmospheres used for pre-conditioning, conditioning and testing shall be in accordance with ISO 139. Condition the entire samples for a minimum of 12 h prior to testing and keep them conditioned during testing.

7 Procedure

7.1 Sampling

7.1.1 Sample length

The test length of each sizing skein shall be 112,5 m obtained from 100 revolutions of the wrap reel. When the reel circumference of (1 000 ± 2,5) mm is used, the number of revolutions shall be 112,5.

7.1.2 Sample quantity

The number of sizing skeins shall be a multiple of 50, subject to specific silk material specifications or agreement between parties concerned. Otherwise, take the skeins as follows:

— 100 sizing skeins, for a nominal size of silk yarn ≥78 dtex (70 den);

— 200 sizing skeins, for a nominal size of silk yarn <78 dtex (70 den).

7.2 Preparation

7.2.1 The number of packages (skein or cone) for the laboratory sample shall be no less than 10.

7.2.2 For silk in skeins, wind the silk onto bobbins. For silk on cones, prepare sizing skeins directly.

7.2.3 Put the silk bobbins or cones upright on the wrap reel, and then reel the sizing skein up to a total length of 112,5 m from each silk bobbin or cone. Prepare the sizing skein neatly by tying the two thread ends tightly, with a knot no longer than 1 cm. Reel and prepare a specified quantity (7.1.2) of silk samples for weighing.

7.3 Weighing

7.3.1 Sort every 50 sizing skeins as one group and weigh each skein on a balance or size tester one by one.

7.3.1.1 With a balance, weigh the sizing skeins of each group on the balance one by one, and record the mass of each sizing skein. Calculate each corresponding size value, and then record the size of each sizing skein according to the following rounding provisions:

— <56 dtex (50 den): to the nearest 0,5 dtex (den);

— ≥56 dtex (50 den) and <167 dtex (150 den): to the nearest 1,0 dtex (den);

— ≥167 dtex (150 den): to the nearest 2,0 dtex (den).

7.3.1.2 With a size tester, weigh the sizing skeins of each group on the size tester one by one, and then record the size of each sizing skein according to the rounding provisions specified in 7.3.1.1.

7.3.2 Weigh all the 50 sizing skeins of each group together on the balance to get the total weight, convert the total weight into total size and round the value to the nearest 0,5 dtex (den).

7.4 Data control

7.4.1 Calculate the sum of the sizes of all sizing skeins for each group ("sum of sizes") according to Formula (1) and round the result to one decimal place.

$$S = \sum_{i=1}^{50} d_i \tag{1}$$

where

S is the sum of sizes, expressed in dtex (den);

d_i is the size of each sizing skein, expressed in dtex (den).

7.4.2 Calculate the difference between the sum of sizes (7.4.1) and the total size (7.3.2) of each group, and compare it with the tolerance specified in Table 1. If the difference is beyond the specified tolerance, repeat the weighing process (7.3.1 and 7.3.2) directly or after regrouping the skeins until the difference is within the specified tolerance.

Table 1 — Tolerance between total size and sum of sizes

Nominal size dtex (den)	Tolerance dtex (den)
37,0 (33,0) and below	3,9 (3,5)
38,0 to 54,0 (34,0 to 49,0)	7,8 (7,0)
55,0 to 110,0 (50,0 to 99,0)	15,6 (14,0)
111,0 to 166,0 (100,0 to 149,0)	31,1 (28,0)
167,0 (150,0) and above	48,9 (44,0)

7.5 Conditioned size

After the size test (7.3.1 and 7.3.2), put all the tested sizing skeins into baskets or other comparable containers in the oven (5.4) loosely and evenly. Dry them to constant mass at (140 ± 2) °C in accordance with the specifications of ISO 6741-1:1989, Table 1. Weigh the sizing skeins at the specified time interval. When the difference between masses weighed at two successive times is smaller than 0,1 % of the second weighed mass, this second weighed mass shall be considered as the constant mass. The determination of drying time is described in Annex A.

The difference between conditioned size and average size can be used to check and control the oven-dry errors or atmosphere conditions during the conditioned size test. It should not surpass the tolerances listed in Table B.1. Otherwise, the size test procedure (see Clause 7) should be repeated.

8 Calculations

8.1 General

Calculate the average size, size deviation, maximum size deviation, conditioned size and coefficient of variation of size according to 8.2 to 8.6, respectively, and round off the numerical values to the second decimal place.

An example of the test results is given in Annex C.

8.2 Average size

Calculate the average size according to Formula (2):

$$\bar{d} = \frac{\sum\limits_{i=1}^{N} d_i}{N}$$

(2)

where

$\bar{d}$ is the average size, in dtex (den);

d_i is the size of each sizing skein, in dtex (den);

N is the total number of sizing skeins.

8.3 Size deviation

Calculate the size deviation according to Formula (3):

$$\sigma = \sqrt{\frac{\sum\limits_{i=1}^{N} (d_i - \bar{d})^2}{N}}$$

(3)

where

σ is the size deviation of all the sizing skeins, in dtex (den);

d_i is the size of each sizing skein, in dtex (den);

$\bar{d}$ is the average size, in dtex (den);

N is the total number of sizing skeins.

8.4 Maximum size deviation

Calculate the average size of the finest and the coarsest sizing skeins (taking 2 % of all the sizing skeins for each) respectively. Determine the difference between the average size as calculated in 8.2 and the average size of the finest skeins, and the difference between the average size as calculated in 8.2 and the average size of the coarsest skeins. Record the higher of these two differences as the maximum size deviation.

8.5 Conditioned size

Calculate the conditioned size according to Formula (4):

$$d_K = \frac{m_0 \times w \times l}{n \times T \times s}$$

(4)

where

d_K is the conditioned size, in dtex (den);

m_0 is the moisture-free mass of all sizing skeins, in g;

w is 1,11 (this factor takes into account the conventional moisture regain, 11 % for silk yarns);

l is 9 000 if the size is in den; 10 000 if it is in dtex;

n is the total number of sizing skeins;

T is the number of revolutions of the wrap reel;

s is 1,125, if the reel circumference is (1 125 ± 2,5) mm;1 if it is (1 000 ± 2,5) mm, in m.

8.6 CV_{size}

Calculate CV_{size} according to Formula (5):

$$CV_d = \frac{\sqrt{\sum_{i=1}^{N}(d_i - \bar{d})^2 / N}}{\bar{d}} \times 100 \tag{5}$$

where

CV_d is the coefficient of variation of size, in percent, i.e. CV_{size};

d_i is the size of each sizing skein, in dtex (den);

$\bar{d}$ is the average size, in dtex (den);

N is the total number of sizing skeins.

9   Test report

The test report shall include the following information:

a)   a reference to this document, i.e. ISO 21046:2018;

b)   a description of the sample, i.e. its nominal size, package type and package quantity;

c)   the length of each sizing skein and the number of sizing skeins;

d)   the test results: average size, conditioned size, size deviation, maximum size deviation and CV_{size};

e)   any deviation, by agreement or otherwise, from the specified procedure;

f)   any unusual feature observed;

g)   the date of the test.

Annex A
(informative)

Determination of drying time

The drying time of the same silk sample can have different features due to different properties of the ovens and external factors. In order to avoid false drying equilibrium, different drying times and time intervals between successive weighings shall be observed depending on the actual situation.

The suitable drying time and time interval between successive weighings can be determined as follows.

— Perform preliminary experiments to record the mass losses corresponding to different drying times.

— Draw the relation curve between mass loss and drying time, i.e. the drying characteristic curve.

— Use the drying time which corresponds to a mass loss of 98 % of the final mass loss as the initial drying duration after which the weighing formally begins.

— The time interval of weighing shall be 20 % of the initial drying duration.

Annex B
(informative)

Tolerance between conditioned size and average size

Table B.1 — Tolerance between conditioned size and average size

Nominal size dtex (den)	Tolerance dtex (den)
20,0 (18,0) and below	0,3 (0,3)
21,0 to 37,0 (19,0 to 33,0)	0,6 (0,5)
38,0 to 54,0 (34,0 to 49,0)	0,8 (0,7)
55,0 to 77,0 (50,0 to 69,0)	1,0 (1,0)
78,0 to 110,0 (70,0 to 99,0)	1,7 (1,5)
111,0 to 166,0 (100,0 to 149,0)	2,2 (2,0)
167,0 to 221,0 (150,0 to 199,0)	3,3 (3,0)
222,0 (200,0) and above	4,4 (4,0)
NOTE The conventional moisture regain in this table is 11,0 %.	