International Standard

ISO 6989

Textile fibres — Determination of length and length distribution of staple fibres (by measurement of single fibres)

Fibres textiles — Détermination de la longueur et de la distribution de longueur des fibres discontinues (par le mesurage de fibres individuelles)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 6989 was developed by Technical Committee ISO/TC 38, *Textiles*, and was circulated to the member bodies in November 1979.

It has been approved by the member bodies of the following countries :

Australia	France	Portugal
Belgium	Germany, F.R.	Romania
Brazil	Ghana	South Africa, Rep. of
Bulgaria	India	Spain
Canada	Israel	Sweden
China	Italy	Switzerland
Cyprus	Korea, Rep. of	Turkey
Czechoslovakia	Netherlands	United Kingdom
Denmark	New Zealand	USA
Egypt, Arab Rep. of	Norway	
Finland	Poland	

The member bodies of the following countries expressed disapproval of the document on technical grounds :

Hungary
Japan
USSR

Textile fibres — Determination of length and length distribution of staple fibres (by measurement of single fibres)

0 Introduction

This International Standard is intended to replace two existing International Standards, ISO 270, *Textile fibres — Determination of fibre length by measuring individual fibres*, and ISO 1822, *Wool — Determination of fibre length using a single-fibre length measuring machine.*

The determination of fibre length by measuring the length of individual fibres is advocated for the following reasons :

    a) the fibre length is better defined than by measurement of the fibre held in combs;

    b) this is a general method, and its range of application is not limited by the length or diameter of the fibres tested;

    c) the risk of accidental or systematic errors is less than with other methods, particularly with collective measurements of the length of a group of fibres.

It should be noted that measurements by this method are made on straightened fibres with the crimp removed, and may give different results from those obtained by other methods of measurement. In the case of fibres which have inherent crimp, straightening the fibres may also include errors due to stretching. Nevertheless, other methods (for example, the comb sorter) are quicker for some fibres (for example, cotton or other short fibres), and for this reason may be preferred, for routine tests, to the more exact method of measuring individual fibre lengths.

ISO 2646, *Wool — Measurement of the length of fibres processed on the worsted system, using a fibre diagram machine,* may be used for the determination of the distribution of the length of fibres by measurement carried out on specimens of sliver processed on the worsted system.

1 Scope and field of application

This International Standard specifies

    — three methods for determination of the length of staple fibres by measuring individual fibres;

    — different methods of expressing the length distribution from values obtained by measurement of individual fibres.

It applies to all discontinuous textile fibres, except those in which strong inherent crimp would render the procedure inapplicable. It does not apply to fibrous bundles of bast fibres.

2 References

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

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

3 Principle

Measurement of the individual length of each fibre

    — method A : on a straightened fibre on a graduated rule, under a light tension applied with the aid of forceps and grease. This method shall be used for reference in cases of dispute, unless strong inherent crimp renders it inapplicable.

    — method B : by measuring by use of an opisometer the length of the image of the fibre enlarged by projection on a screen.

    — method C : by use of a semi-mechanical device.

Expression of the length distribution of fibres from the values of fibre length, classing the fibres into groups of length.

4 Apparatus and materials

4.1 Method A (Reference method)

4.1.1 Polished glass plate, with a millimetre scale engraved or photographed on it.

4.1.2 Pointed forceps.

4.1.3 White petroleum jelly or **liquid paraffin.**

4.2 Method B

4.2.1 Projector and screen, with means for mounting fibres on the projector slide.

4.2.2 Opisometer and calibration slide, or other means for determining projector magnification.

4.2.3 White petroleum jelly or **liquid paraffin.**

4.3 Method C

4.3.1 Apparatus for carrying out semi-automatic measurement of the fibre length under controlled tension, classification of fibre length in groups or classes in intervals of determined length, and registering the number of fibres in each of these groups.

A convenient apparatus for use in this method is described in the annex.

4.3.2 Pointed forceps.

4.3.3 Short graduated rule, having two marks, 5 mm apart.

5 Atmospheres for conditioning and testing

Condition the fibres and keep them in the standard atmosphere for testing, as defined in ISO 139, i.e. an atmosphere having a relative humidity of (65 ± 2) % and a temperature of 20 ± 2 °C, until they are in equilibrium with that atmosphere. If the laboratory sample of fibres is in an open state, a conditioning time of 1 h is usually sufficient.

Test the fibres in the standard atmosphere for testing.

6 Test specimen

6.1 Sampling

Take the laboratory sample in accordance with ISO 1130. Take fibres forming the test specimens at random from the laboratory sample in order to obtain a "numerical" test sample (see ISO 1130).

6.2 Number of tests

Take 500 fibres from the laboratory sample and determine their length. From these individual lengths, calculate the 95 % confidence limits (see 8.2.3).

Increase the number of fibres, if necessary, to reduce the relative value to 5 % or less, according to practical needs.

NOTE — In the case of man-made staple fibres, a smaller number of fibres may be sufficient to obtain the required precision, and may be used, subject to the agreement of the interested parties.

7 Procedure

7.1 Measurement of fibre length

7.1.1 Method A (Reference method). Measurement of length of individual fibres on a graduated glass plate

Smear the glass plate (4.1.1) with a small quantity of the white petroleum jelly or liquid paraffin (4.1.3). Using the forceps (4.1.2), arrange a fibre in a straight line on the glass plate and along the scale, keeping it straight by applying a minimum ten-sion at its two extremities. Measure the length of the fibre along the scale. Repeat the operation for each fibre to be tested.

7.1.2 Method B. Measurement of the length of the image of a fibre

Smear the slide (4.2.2) with a thin film of the white petroleum jelly or liquid paraffin (4.2.3), applied with a paper tissue. Lay a convenient number of fibres on the oiled slide; bend the fibres if they are longer that the projection field. Place a clean cover-glass on top of the fibres and hold the assembly firmly together with a small piece of adhesive tape.

For fibres less than 90 mm in length, use a magnification of 10 ×. For longer fibres, a magnification of 5 × is sufficient.

Determine the magnification of the equipment by measuring the image length of the calibration slide with the opisometer (4.2.2). Measure the length of the images of the fibres in turn with the opisometer.

Calculate the individual fibre length using the magnification previously determined.

7.1.3 Method C. Use of a semi-automatic apparatus

Using the pointed forceps (4.3.2), grip each fibre successively, as near to the end as possible, and pull it over the approach pad into the traverse screw. A device detects the upper end of the fibre and stops the traverse screw so that the distance traversed is known and thus the fibre-length is determined. The fibre lengths are classified in such a way that the number of fibres in each group is recorded automatically in the course of the length determinations. Fibres shorter than 5 mm shall be classed visually using the rule (4.3.3).

7.2 Classing of fibres (for methods A and B)

7.2.1 Group the observed lengths in classes, the interval between these being for example as follows :

Nominal length of fibres mm	Class interval mm
Less than or equal to 45	1
More than 45 and less than or equal to 80	2
More than 80	5

(Other class intervals may be used subject to agreement between the interested parties.)

7.2.2 Observe the class limits given by the following deviations from the mid-points of the classes :

Nominal length of fibres by reference to the mid-point of the class	Class interval mm
1	+ 0,50 − 0,49
2	+ 1,00 − 0,99
5	+ 2,50 − 2,49

8 Calculation and expression of results

8.1 Method of calculation

NOTE — In the case of square-cut, man-made staple fibres, take no account in subsequent calculations (but report the occurrence) of extreme fibre classes containing less than 1 % of fibres, if the preceding class does not contain at least 1 % of the fibres.

Count the number of fibres (n_i) in each class, of length l_i. Calculate for each class the percentage frequency by number f_i, using the formula

$$f_i = \frac{n_i}{\Sigma n_i} \times 100$$

and the percentage length-biased frequency f'_i using the formula

$$f'_i = \frac{n_i l_i}{\Sigma n_i l_i} \times 100$$

where

n_i is the number of fibres in the ith class;

l_i is the central length of the ith class, in millimetres;

Σn_i is the total number of fibres in all classes;

$\Sigma n_i l_i$ is the sum of the products $n_i \times l_i$ for all classes.

This latter value coincides with the percentage frequency by mass only if fibres of different lengths have the same mass per unit length. This is not always the case, especially for natural fibres.

8.2 Characteristic distribution values

8.2.1 Lengths

The following characteristic distribution values are commonly calculated (other quantities may also be calculated for particular purposes) :

a) the modal length (the central length of the most numerous class);

b) the mean length of the individual fibres :

$$L = \frac{\Sigma n_i l_i}{\Sigma n_i}$$

c) the length-biased mean length of fibres in a sliver, roving or yarn section :

$$L' = \frac{\Sigma n_i l_i^2}{\Sigma n_i l_i}$$

Express these lengths in millimetres.

8.2.2 Coefficient of variation

Calculate this coefficient from the frequency distribution using the formula

$$CV \% = \frac{s}{L} \times 100$$

where the standard deviation s is given, in millimetres, by the formula

$$s = \left(\frac{\Sigma (l_i - L)^2 n_i}{\Sigma n_i} \right)^{1/2}$$

However, if the values L and L' are calculated, the coefficient of variation may be calculated by using the formula

$$CV \% = 100 \left(\frac{L'}{L} - 1 \right)^{1/2}$$

8.2.3 95 % confidence limits

— in absolute value : $\Delta \text{ (mm)} = \pm \dfrac{1,96 \, s}{\sqrt{n_i}}$

— relative value : $\Delta \% = \pm \dfrac{1,96 \, CV}{\sqrt{n_i}}$

8.2.4 Expression of the frequency distribution

If a length distribution graph is required, express it

— by a frequency histogram representing the percentage of the number of fibres in each length interval employed, expressed as a function of the length;

— by a cumulative frequency diagram indicating the percentage as a function of fibres greater than a given length, expressed as a function of the length.

9 Test report

The test report shall include the following particulars.

9.1 The number of fibres measured :

— the mean length of individual fibres L;

— the coefficient of variation;

— the frequency histogram or the cumulative frequency diagram, if a distribution graph is required;

— the number of fibres, if not zero, in any classes excluded from the calculation of mean length and coefficient of variation.

9.2   If required :

—   the percentage by number of the fibres in each class;

—   the class intervals used;

—   the modal class length;

—   the length-biased mean length of the fibres;

—   the confidence limits (normally the 95 % confidence limits).

9.3   Reference to this International Standard and the method used, including the type of apparatus if method C was employed.

9.4   All operations not specified in this International Standard, and all incidents likely to have had an effect on the results.