UDC 677.3:531.717

Ref. No.: ISO/R 137 - 1960 (E)

ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION
R 137

DETERMINATION OF WOOL FIBRE DIAMETER

PROJECTION MICROSCOPE METHOD

1st EDITION

January 1960

For each individual country the only valid standard is the national standard of that country.

Printed in Switzerland

Also issued in French and Russian. Copies to be obtained through the national standards organizations.

BRIEF HISTORY

The ISO Recommendation R 137, *Determination of Wool Fibre Diameter–Projection Microscope Method*, was drawn up by Technical Committee ISO/TC 38, *Textiles*, the Secretariat of which is held by the British Standards Institution (B.S.I.).

At its first meeting, held in Buxton in June 1948, the Technical Committee decided to add the subject of fibre testing to its programme of work and to appoint a Sub-Committee, SC 6, *Fibre Testing*, to deal with it.

At its second meeting, held in Bournemouth in June 1951, the Technical Committee approved a recommendation from the Sub-Committee SC 6 that methods for the determination of fibre number or fineness should be developed.

When detailed attention was given to the question of wool fibres, the Sub-Committee SC 6 agreed that a method evolved by the International Wool Textile Organisation (IWTO) should be taken as the basis of its work. A first draft proposal on those lines was subsequently prepared and was unanimously adopted at the third meeting of the Technical Committee, held in Southport in May 1956, as a Draft ISO Recommendation.

On 15 October 1957, the Draft ISO Recommendation (No. 181) was distributed to all the ISO Member Bodies and was approved, subject to some editorial amendments, by the following Member Bodies:

Australia	Hungary	Portugal
Austria	India	Romania
Belgium	Israel	Spain
Burma	Italy	Sweden
Canada	Japan	Switzerland
Czechoslovakia	Netherlands	Turkey
Denmark	New Zealand	United Kingdom
France	Norway	U.S.A.
Germany	Pakistan	U.S.S.R.
Greece	Poland	

No Member Body opposed the approval of the Draft.

The Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided, in January 1960, to accept it as an ISO RECOMMENDATION.

ISO Recommendation R 137 January 1960

DETERMINATION OF WOOL FIBRE DIAMETER
PROJECTION MICROSCOPE METHOD

FOREWORD

The method of measuring fibre diameter by the projection microscope is used throughout the world in various forms and is thus appropriate for international standardization. The method is suitable for wool fibres in any form and also for other fibres of reasonably circular cross-section.*

1. SCOPE

This method sets out the procedure and the conditions of measurement for the determination of wool fibre diameter by means of the projection microscope.

2. PRINCIPLE

The principle of the method consists of projection on a screen of the images of the profiles of wool fibre pieces and measuring the width by means of a graduated scale. The operating technique assures a random sampling of the fibres to be measured.

3. APPARATUS

3.1 Microtome

For preparing the test specimen, use a microtome, an instrument for cutting the fibres to a determined length.

The microtome consists of a steel plate with a slot and a steel tongue, fixed to the guides which slide along the plate, adjustable in such a manner that it enters the slot to a predetermined distance. A steel blade pusher is equal in thickness to the width of the microtome slot and has a stop plate placed at a determined distance from one of its ends: a set of three pushers should be available, the stop plates of which are placed at distances of 0.8 mm, 0.6 mm and 0.4 mm from one of their ends.

TABLE 1.—Choice of pushers

Fibres		Pushers
Form	Average diameter	Distance between stop plate and pusher's end
	microns μ	millimetres
Slivers and rovings	> 27	0.8
	< 27	0.4
Yarns	> 27	0.6
	< 27	0.4

* In the case of dyed, bleached or finished fibres, it should be noted that the diameter may be different from that of fibres not subjected to such treatments. The estimates of fibre diameter obtained at the various stages of processing one lot of wool will not necessarily be the same.

3.2 Projection microscope

The projection microscope comprises a light source, a light condenser, a stage which supports the prepared fibres, an objective, an ocular and a circular screen.

3.2.1 *The stage* is movable in two directions at right-angles by means of an intermediary sliding mechanism capable of successive displacements at 0.5 mm steps.

3.2.2 *The objective and ocular* are capable of providing 500× magnification.

3.2.3 *The circular screen* is able to rotate around its centre in its plane.

If this screen is not transparent, it should carry a transparent scale, 5 cm wide, graduated in millimetres along its underside; this scale can be moved diametrically across the screen between guides.

Transparent screens may carry scales graduated in millimetres along one diameter or along two perpendicular diameters.

In the centre of the circular screen there is a circle whose diameter is equal to a quarter of the optical distance between the ocular and the centre of the screen. All measurements are made inside this circle.

3.2.4 *Calibration.* The projection microscope should be calibrated periodically by means of a micrometer scale (certified accurate), divided in hundredths of a millimetre and placed on the stage. One division of the micrometer (i.e. 0.01 mm), projected on the screen, should cover exactly 5 mm of the graduated scale. The magnification is then equal to 500×.

3.3 Mounting medium (for the preparation of the specimen)

Provide a mounting medium with the following properties:

(a) a refractive index between 1.43 and 1.53,

(b) suitable viscosity,

(c) zero water absorption.

Cedar wood oil and liquid paraffin are examples of suitable media.

4. PREPARATION OF SPECIMENS

4.1 Sampling

Specimens in the form of sliver, roving or yarn are placed in the slot of the open microtome, occupying the slot to a sufficient depth. Long fibres are generally thick fibres, and consequently any manipulation resulting in selection of long fibres will give too great an average diameter. Raw wool or loose fibres in any form are sampled as described in Appendix 1.

4.2 Conditioning

Condition the fibres to equilibrium in an atmosphere whose relative humidity is 65 ± 2 per cent and temperature 20 ± 2 °C.*

* See ISO Recommendation R 139, *Standard Atmospheres for Conditioning and for Determining the Physical and Mechanical Properties of Textiles.*

4.3 Cutting by microtome

Place the specimen in the microtome slot. Then insert the steel tongue and push it strongly to compress the sliver. With a razor-blade cut off the projecting fibres flush with both faces of the steel plate. The cut part of the fibres will then remain in the microtome slot. By forcing the pusher from one side, the cut fibres will appear on the opposite side, at the length of 0.8 mm, 0.6 mm and 0.4 mm, according to the pusher used. With a razor-blade, cut the emerging fibres flush with the steel plate.

4.4 Mounting of specimens

Place all the fibres cut with the microtome on a slide and mix with a few drops of mounting medium until the specimens are completely and evenly distributed.

Remove sufficient of the mixture before covering the slide to ensure that no oil is squeezed from under the cover-glass when it is placed on. This will ensure no preferential removal of thin fibres.

5. PROCEDURE

5.1 Examination of the specimen

The slide is then placed on the microscope stage, the cover-glass towards the objective.

After the fibres have settled, the specimen is examined in different fields. The distance between the centres of the fields should be theoretically greater than the length of the cut fibres, otherwise the same cut fibre could be measured twice. However, if the centres are only 0.5 mm apart, the probability of measuring the same cut fibre twice is slight enough to be overlooked. Thus the sliding mechanism should be provided with means for traversing by 0.5 mm steps. A system of fields whose centres are 0.5 mm apart will be adequate.

Begin the examination by focusing first the corner A of the glass slide. Move the specimen 0.5 mm in the transverse direction to B, then move it 0.5 mm in the lateral direction. These two traverses will bring the first field on the screen. Measure the diameter of each fibre within the circle of the field, following the established rules, as follows:

These should be excluded:

(a) Fibres which have more than half their width outside the circle,

(b) Fibres which end within the width of the transparent scale,

(c) Fibres which cross another fibre at the point of measurement.

The stage should remain stationary during the measurement in a given field. It may happen that in a field there will be no fibres at all, or only one or two.

When the fibres have been measured in one field, move the specimen 0.5 mm in the lateral direction. Continue in this way along the whole length of the slide. Having reached C, move 0.5 mm in the transverse direction, to D, and continue examination laterally by 0.5 mm steps, and so on. Cover all the slide in this way, following the path A, B, C, D, E, F, G...

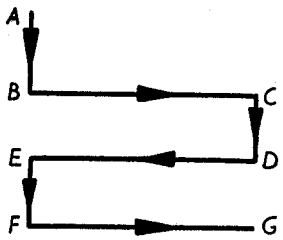


FIG. 1.—**Examination of the specimen**

By following this procedure, the operator has no free choice of the fibres to be measured.

5.2 Focusing

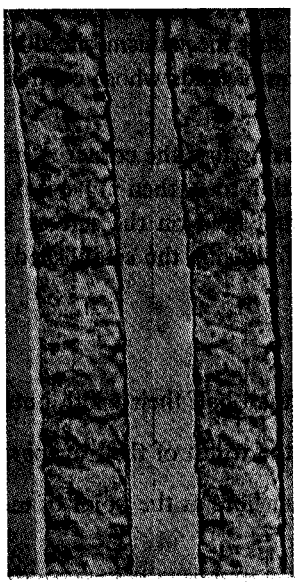
When the lens is too near the slide, a fibre edge shows a white border. When the lens is too far from the slide, a fibre edge shows a black border.

When in focus, the fibre edge shows as a fine line without a border. However, it is not usual for both edges of a fibre image to be in focus together, since wool fibres are in general non-circular in cross-section.

When measuring a fibre whose edges are not in focus together, the focusing should be so adjusted that one edge is in focus and the other shows a white line. The measurement of width is then made from the edge that is in focus to the inside of the white line. The figure shows a fibre correctly and incorrectly focused.

FIG. 2 (a)

Correctly focused fibre with one sharp edge and with Becke line.



Correct *Incorrect*

FIG. 2 (b)

Incorrectly focused fibre with black Becke line.

5.3 Recording of measurements

For each fibre, bring one of the principal divisions of the graduated scale tangentially to the focused edge of the fibre. Read the diameter up to the other side of the fibre, remembering the comments in the previous paragraph. The results of the measurements can be entered on a form, e.g. a working sheet (see Appendix 2).

Generally, the second side of the fibre falls between two divisions of the scale. Enter it under the lower whole number of millimetres N. In the subsequent calculation, all fibres recorded under N will be regarded as having a diameter equal to: $N + 0.5$ mm.

However, it sometimes happens that the diameter of a fibre corresponds exactly with a whole number of millimetres N; this fibre belongs at the same time to the $N-0.5$ group (recorded as $N-1$) and to the $N + 0.5$ group (recorded as N). If such a fibre is recorded under the $N - 1$ group, it is called "underestimated"; if it is entered in the N group, it is called " over-estimated ".

When such fibres, measuring an exact number of millimetres, occur, they are underestimated and over-estimated alternately.

6. EXPRESSION OF RESULTS

Calculate the mean arithmetic measurement in millimetres; the average diameter of fibres in microns (μ), at a magnification of 500×, will be obtained by multiplying the mean arithmetic measurement by two.

Then calculate the coefficient of variation CV, as a percentage, from the following formula:

$$CV \text{ (as a percentage)} = \frac{100\ S}{\bar{x}}$$

where S = standard deviation,

$\bar{x}$ = average value of diameter.

APPENDIX 1

Sampling of loose fibres of raw wool

The material is first sampled in the following manner. The bulk is divided in to about 40 zones, and a tuft, lock or handful of fibres is taken from each zone. Each portion is divided into two (taking care to avoid breaking the fibres) and half is rejected, the half to be rejected being chosen at random. If the fibres are naturally grouped in locks of parallel fibres, the division into two parts is done lengthwise, i.e. in a direction which avoids selecting the fibres by their ends. The retained half is again divided into two, and one half is rejected at random. This process is continued until about 25 fibres remain in each portion. The composite sample of about 1000 fibres is then given a washing treatment consisting of two extractions in benzene or petrol ether. The sample is then cut up with scissors on a glass plate into fibre pieces from ½ mm to 1 mm long. The cut pieces are divided into 16 zones, from each of which a small quantity is taken and placed in a few drops of mounting medium, on a glass slide about 75×40 mm (3×1½ in). The fibre pieces are then stirred well into the mounting medium to obtain uniform distribution. A cover-glass 50×35 mm (2×1$^3/_8$ in), No. 1 (i.e. 0.13 to 0.17 mm thickness), is lowered onto the slide by placing one edge in contact with the slide, and gently lowering the opposite edge on to the slide.

APPENDIX 2

Working sheet **Example of calculation**

1	2	3	4	5	6
Group (Average diameter in milli-metres)		*F*	*e*	*Fe*	*(Fe)e*
1					
2					
3					
4	.	1	6	6	36
5	..	2	5	10	50
6	....	9	4	36	144
7	....	26	3	78	234
8	....	48	2	96	192
9	....	49	1	49	49
10	....	63			
11	....	43	1	43	43
12	....	22	2	44	88
13	....	26	3	78	234
14	....	18	4	72	288
15	....	4	5	20	100
16	....	4	6	24	144
17	.....	5	7	35	245
18		0	8	0	0
19	..	2	9	18	162
20		0	10	0	0
21	.	1	11	11	121
22					
23					
24					
25					
		323		−275 +345	2 130

$-275 + 345 = +70$

$+70 : 323 = +0.22$

$10.50 + 0.22 = 10.72$

Mean arithmetic measurement, in millimetres $= 10.72$

Average diameter, in microns (μ) $= 21.44$

$$\text{Correction} = \frac{70^2}{323} = 15$$

$2130 - 15 = 2115$

$2115 : 323 = 6.55$

$\sqrt{6.55} = 2.56$

Standard deviation $= 2 \times 2.56 = 5.12$

Coefficient of variation

$$= \frac{5.12 \times 100}{21.44} = 23.9 \text{ per cent}$$