International Standard 2370

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Textiles — Determination of fineness of flax fibres — Permeametric methods

Textiles — Détermination de la finesse des fibres de lin — Méthodes perméamétriques

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Foreword

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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 2370 was developed by Technical Committee ISO/TC 38, *Textiles*, and was circulated to the member bodies in August 1979.

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

Belgium	Israel	Romania
Canada	Japan	South Africa, Rep. of
Cyprus	Korea, Rep. of	Spain
Czechoslovakia	Libyan Arab Jamahiriya	Sweden
Egypt, Arab Rep. of	Netherlands	Switzerland
France	New Zealand	Turkey
Germany, F.R.	Norway	USSR
Ghana	Poland	
Hungary	Portugal	

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

Italy
United Kingdom

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Printed in Switzerland

Textiles — Determination of fineness of flax fibres — Permeametric methods

0 Introduction

Fineness can be considered as a vital characteristic of flax. However, because of their special structure, the measurement of the fineness of such fibres presents a difficult problem.

Whereas cotton, wool, man-made fibres, etc., form individual fibres of a given dimension and are easily separated one from the other, flax fibres form, after retting and scutching, fibre strands. These consist of a certain number of ultimate fibres, bound together more or less imperfectly by pectic substances which give certain fibres a branching form. During the spinning operations, these fibre strands are progressively divided without such a process ending in the complete separation into ultimate fibres.

In these conditions, determination of the fineness of flax fibres presents the following difficulties :

— in the first place, a difficulty arises from the continuous alteration of the amount of division of the substance during the spinning. One cannot therefore refer to fineness as such, but only to fineness corresponding to a state consecutive to a given operation. It will therefore always be necessary to specify the state in which the substance is found when making any measurement;

— a second difficulty, which also results from the constitution of the substance, lies in the fact that the separation of the fibrous elements is a delicate operation.

Taking these difficulties into account, "permeametric" methods based on the Kozeny equation (see annex C) seem most suitable for measuring the fineness of bast.

1 Scope and field of application

This International Standard specifies two permeametric methods for the determination of the fineness of flax fibres :

— a reference method, with two compressions, using a test piece of parallel fibres (clause 5);

— a simplified method, with one compression, using a test piece of fibres distributed "at random" (clause 6).

These methods apply to the various forms possible for flax fibres, i.e. long strands, broken strands, all kinds of tow and at all stages of manufacture of these substances.

2 References

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

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

3 Definitions

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

3.1 wads of fibres (forming the test piece) : A fibrous mass introduced into the centre channel of a cylindrical casing and on which the measurement will be made.

In the reference method, the fibrous elements forming the wad are placed parallel to the axis of the casing. In the simplified method, the fibrous mass is introduced into a chamber so that the fibres forming the wad are placed at random. In both methods it is essential that the density of the filling is as regular as possible.

3.2 resistance R of a wad of fibres (forming the test piece) to the passage of air in laminar flow : Quotient of depression $\triangle P$ (mbar) produced by the wad of fibres to flow Q (cm^3/s) passing through it :

$$R = \frac{\triangle P}{Q} \text{ (mbar·s/cm}^3\text{)}$$

If $\triangle h$ is the difference in level, in centimetres, (read at the vertical) of a water gauge, one can write :

$$R = \frac{g\varrho \times \triangle h}{Q}$$

where

g is the acceleration due to gravity, considered as equal to 981 cm/s^2;

ϱ is the density of water, i.e. 1 g/cm^3.

Numerically, resistance R will be equal to

$$\frac{0{,}98\ \triangle h}{Q}\ (\text{mbar}\cdot\text{s/cm}^3)$$

where

$\triangle h$ is the difference in level, in centimetres;

Q is the flow, in cubic centimetres per second.

3.3 specific surface A of a wad of fibres (forming the test piece) : Quotient of the total side surface of the constituent fibrous elements by their volume, expressed in square centimetres per cubic centimetre (cm^2/cm^3).

3.4 index of specific surface A' of wad of fibres (forming the test piece) : Index defined by the equation[1] :

$$A' = A\sqrt{\mu k}$$

where

A is the specific surface of the wad;

μ is the viscosity of the air;

k is a dimensionless empirical factor of proportionality.

3.5 index of fineness standard (IFS) : Index of fineness determined by a conventional method (gravimetric method) on reference lots. This index (index of fineness IFS), relatively close to values expressed by the Tex System, permits compensation for the fact that the fineness of flax fibres cannot be defined in an absolute manner.

4 Conditioning and test atmosphere

Weighing and measuring shall be carried out in one of the standard atmospheres for conditioning and testing of textiles, defined in ISO 139, on test pieces previously conditioned in the same atmosphere.

5 Reference method

5.1 Principle

Measurement of the resistance to the passage of air of a wad of parallel fibres of given mass placed successively in two casings of specified size but different diameters, then, from the two values obtained, deduction of the index of specific surface of the wad and the density of the fibres, which characterize the fineness of the fibres.

NOTE — Whilst it is usual for certain fibres to take on a well defined density, experience shows that such is not the case with flax fibres; for this reason it is necessary to measure the density of the fibre at the same time as the determination of specific surface index.

5.2 Sampling

Samples shall be representative of a batch.

Sampling shall be carried out by one of the methods given in ISO 1130.

5.3 Test pieces

5.3.1 Shape and mass

The test piece shall consist of a stub of parallel fibres about 80 mm long, having a mass between 2,8 and 3,2 g, depending on the material.

5.3.2 Preparation

5.3.2.1 Scutched or hackled flax

If the material consists of scutched flax (green, retted) or line flax, cut from the desired place (for example top, middle, bottom) stubs approximately 80 mm long and take the mass needed for the test.

5.3.2.2 Flax tow in wads

Carry out carding to make the fibres parallel; this is done by using hand carding machines (see annex A).

5.3.2.3 Slivers or rovings

Take, at intervals, sections about 80 mm long. Bring together the various stubs and take the mass required for the test.

1) See annex C.

5.4 Apparatus

The apparatus shown in figure 1 shall include the following.

5.4.1 Air tap, A, below an air chamber (minimum pressure 1,5 bar) fed by a compressor or by a general dry compressed air line.

5.4.2 Gauge, B, graduated from 0 to 2 bar, with a control device.

5.4.3 Butterfly valve for output control, C, (0,15 to 0,85 cm^3/s).

5.4.4 Three-way tap, D.

5.4.5 Soap bubble output meter, E, or any other apparatus permitting precise measurement of low output.

5.4.6 Measuring chamber, F, into which the casing containing the parallel fibres is placed. The edge of this casing, fitted with a supple joint, comes against the edge of F and is retained there by a threaded cap G having a circular opening.

5.4.7 Water manometer, M, formed by a tube with variable tilt permitting readings of maximum depression corresponding to 250 — 50 — 25 and 12,5 mm, according to the tilt. One of the ends is open to the air and the other connected to the chamber F, as shown in figure 1.

5.4.8 Casings, 10 mm high and with diameters of 10 and 11 mm (to the nearest 10 µm) respectively.

5.4.9 Circular sharp blade, mounted on a rapidly rotating axle.

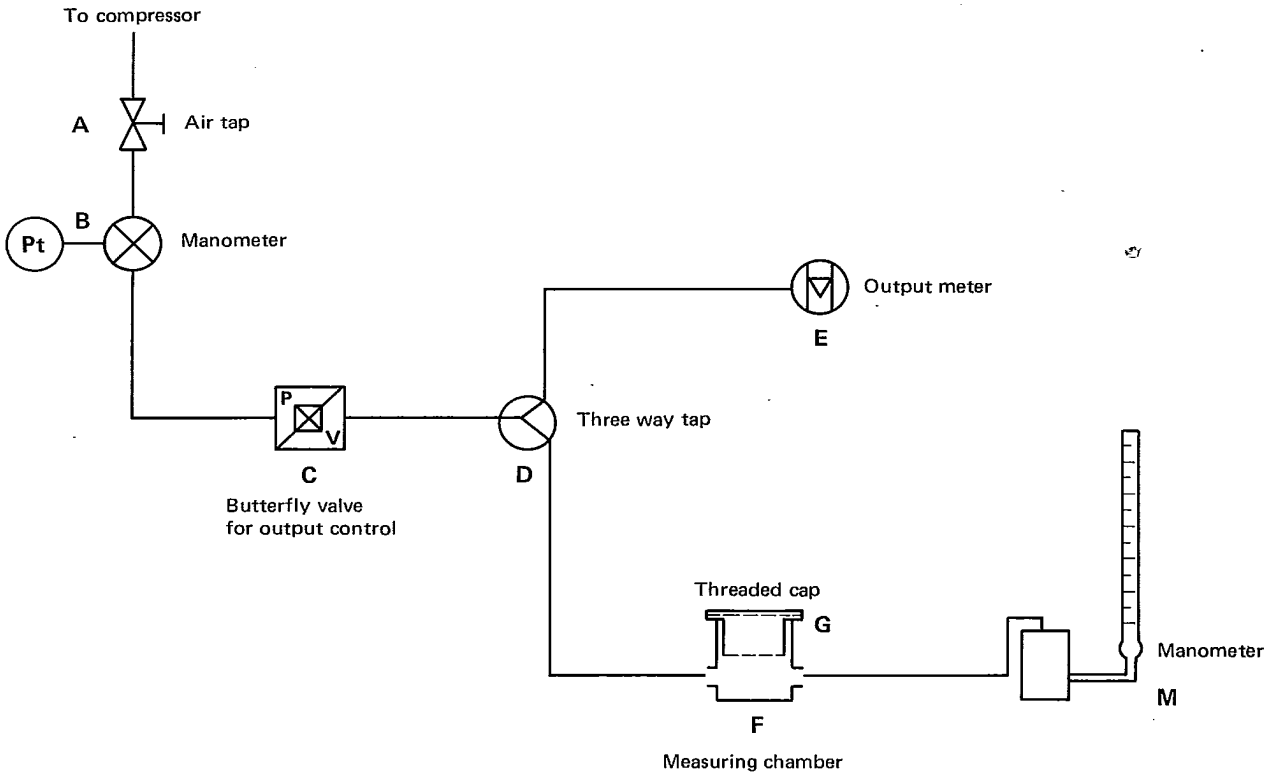


Figure 1 — Apparatus for the reference method

5.5 Procedure

5.5.1 Determination of output

Adjust the output controlled by butterfly valve C to 0,50 ± 0,01 cm^3/s. Determine the exact output before each series of measurements. For this purpose :

— leave the apparatus connected to the flow for 30 min to obtain a stationary flow, the initial pressure being controlled at 1 bar;

— open the three way tap D in the direction of the output meter. Determine the time necessary for a bubble to obtain a predetermined level corresponding to 50 cm^3. Take the mean of five measurements.

The butterfly valve C permits maintenance of the output at a constant value, even in the case of variation of the initial pressure or the counter pressure.

5.5.2 Measurement of resistance R_1

Introduce the parallel fibres of flax (scutched, line, roving) or prepared parallel fibres (tow) into the channel of the 10 mm diameter casing, as shown in figure 2. Cut the fibres which stick out of the channel using the rapidly rotating sharp circular blade; during this operation, the casing shall rotate at a slower speed.

Start the apparatus, introduce the casings into the chamber and screw on the cover G. After stabilization of the pressure, read the height $\triangle h_1$ on the manometer and deduce the resistance R_1, in bar seconds per cubic centimetre, using the formula

$$R = \frac{0{,}98\ \triangle h}{Q}$$

where

$\triangle h$ is the manometer height, in centimetres, read at the vertical on the water manometer;

Q is the output, in cubic centimetres per second, measured in 5.5.1.

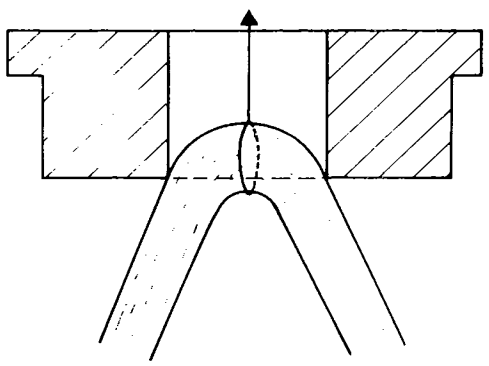


Figure 2 — Introducing the fibres into the casing

5.5.3 Measurement of resistance R_2

Withdraw the casing from the chamber. Place it on the 11 mm diameter casing, so that the axes coincide, and push the wad of fibres into this second casing as shown in figure 3, using a metal ram of 9,8 mm diameter. This transfer of the wad will inevitably create preferential channels. It is essential to eliminate these by the following manual operation; with the casing in the left hand, submit the fibre wad to a transverse vibration between the thumb and second finger of the right hand.

Make a second measurement of the manometric height ($\triangle h_2$), proceeding as indicated in 5.5.2. Deduce from this new measurement the resistance R_2.

Dimensions in millimetres

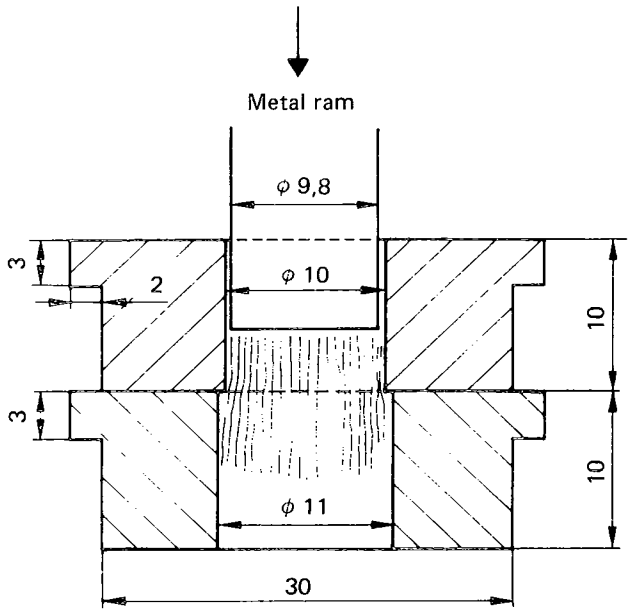


Figure 3 — Transferring the wad of fibres

5.5.4 Determination of the mass of the wad of fibres

Extract the wad of fibres from the casing and determine its mass to the nearest milligram.

5.6 Control of apparatus functioning

It is recommended that two gauges be used for regular control of the apparatus and verification that it is in good working condition. These gauges consist of pieces of metal, of external dimensions equal to those of the casings used for the introduction of the fibres, with a central hole.

The diameter of the central hole of one of the disks shall be chosen to give a reading corresponding to approximately 1/3 of the measurement scale of the manometer, when the disk is placed in the apparatus, the latter being used as when a measurement of fineness is made, but without fibre in the chamber.

The diameter of the central hole of the second disk shall be chosen to give a reading corresponding to approximately 2/3 of the measurement scale of the manometer.

About once per day, place the gauges in the apparatus, passing air through the central hole only, and note the corresponding readings.

The variations in these readings should not exceed, depending on the gauges used, 2 or 4 mm of the scale. This procedure forms a useful and rapid check of the functioning of the apparatus.

5.7 Calculation and expression of results

Calculate the specific surface index A' and the density ϱ of the flax fibre from the formulae

$$A' = A\sqrt{\mu k} = C \times \frac{R_1^{1/2} \times R_2^{1/2}}{(C_1 R_1^{1/3} - C_2 R_2^{1/3}) \sqrt{R_1^{1/3} - R_2^{1/3}}}$$

$$\varrho = m \times \frac{R_1^{1/3} - R_2^{1/3}}{C_1 R_1^{1/3} - C_2 R_2^{1/3}}$$

where

$C_1 = L_{\omega_1}$

$C_2 = L_{\omega_2}$

$C = \sqrt{L\,(\omega_2 - \omega_1)^3}$

L is the height of both casings (1,0 cm);

R_1 and R_2 are the resistances, in millibar seconds per cubic centimetre;

μ is the dynamic viscosity of air (1,81 × 10^7 centinewton seconds per square centimetre);

k is the empirical factor of proportionality without dimensions;

ϱ is the density of the fibrous material, in grams per cubic centimetre;

ω_1 is the section of the first casting (diameter 1,0 cm);

ω_2 is the section of the second casting (diameter 1,1 cm);

m is the mass, in grams, of the wad;

A' is the index of specific surface;

A is the specific surface of the wad, in square centimetres per cubic centimetre.

The parameter A' is characteristic of the fineness; however, by convention, the value of A' shall be used as described in annex B to enable the results to be expressed as an index of fineness standard, IFS.

6 Simplified method

6.1 Principle

Determination of the difference in level produced in a manometric tube by the passage of air through a wad of fibres placed randomly in a casing of known size.

The value of this difference in level $\triangle h$ relates to the fineness of the fibre.

NOTE — Neglecting the variations of density of the fibres, one can consider that

- with a single compression,
- with a constant flow, and
- with a test piece of constant mass,

the measurement of the difference in level $\triangle h$ is sufficient index to judge the fineness of the flax fibres.

6.2 Sampling

The sample shall be representative of the batch.

Sampling shall be carried out by one of the methods given in ISO 1130.

6.3 Test pieces

6.3.1 Shape and mass

The test piece shall consist of a mass of fibres of mass equal to 1,2 ± 0,001 g.

6.3.2 Preparation

6.3.2.1 Scutched or line flax

Take sections of these materials from the hanks.

Subdivide these sections into uncut strips by pinching the fibres in the middle and separating them out crossways. Take a mass slightly greater than that of the test piece. Repeat this operation for each of the test pieces.

6.3.2.2 Raw tow or waste flax

Divide the sample into the number of parts required. From each, take, in several pinches, a slightly greater quantity than the mass of the test piece.

6.3.2.3 Sliver or roving

Starting from one end, eliminate the first tufts taken with the fingers; then take, in successive clumps, lengthways, the quantity necessary to form a test piece.

With the roving, proceed in the same way after unwinding. Avoid shortening the fibres and, in particular, avoid using scissors.

6.3.3 Determination of the mass of the test pieces

Before determining the mass of the test pieces, remove knots, open out wide and homogenise. Then, from this very spread out web, adjust the mass of the test piece to the value specified.

6.3.4 Number of test pieces

Five test pieces are generally sufficient.

6.4 Apparatus

The apparatus (shown schematically in figure 4) shall include the following.

6.4.1 An air tap above a suction pump, with a regular flow of water of at least 500 cm^3/s.

6.4.2 A flowmeter, graduated from 0 to 500 cm^3/s.

6.4.3 A cylindrical measuring chamber with strictly accurate dimensions as shown in figure 5.

6.4.4 A liquid level gauge, with scale graduated in millimetres to a height of 1 000 mm; the tube is immersed in a wide section tank compared to that of the tube, so that the level barely alters. The liquid selected for its density and low volatility is propan-2-ol.

6.4.5 A bottle, of capacity 1 000 ml, with two nozzles, lagged with about 15 g of glass wool to ensure cleanliness of the air.

These different parts shall be connected by flexible piping, absolutely hermetically sealed, and without constriction.

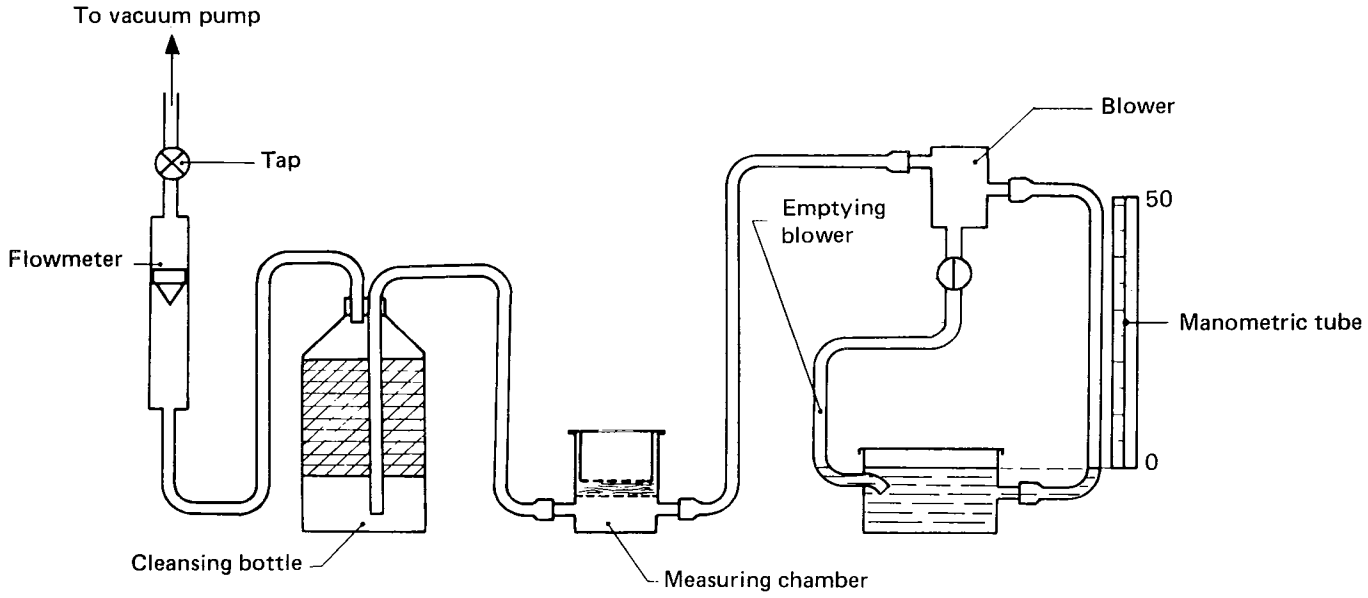


Figure 4 — Apparatus for the simplified method

Dimensions in millimetres

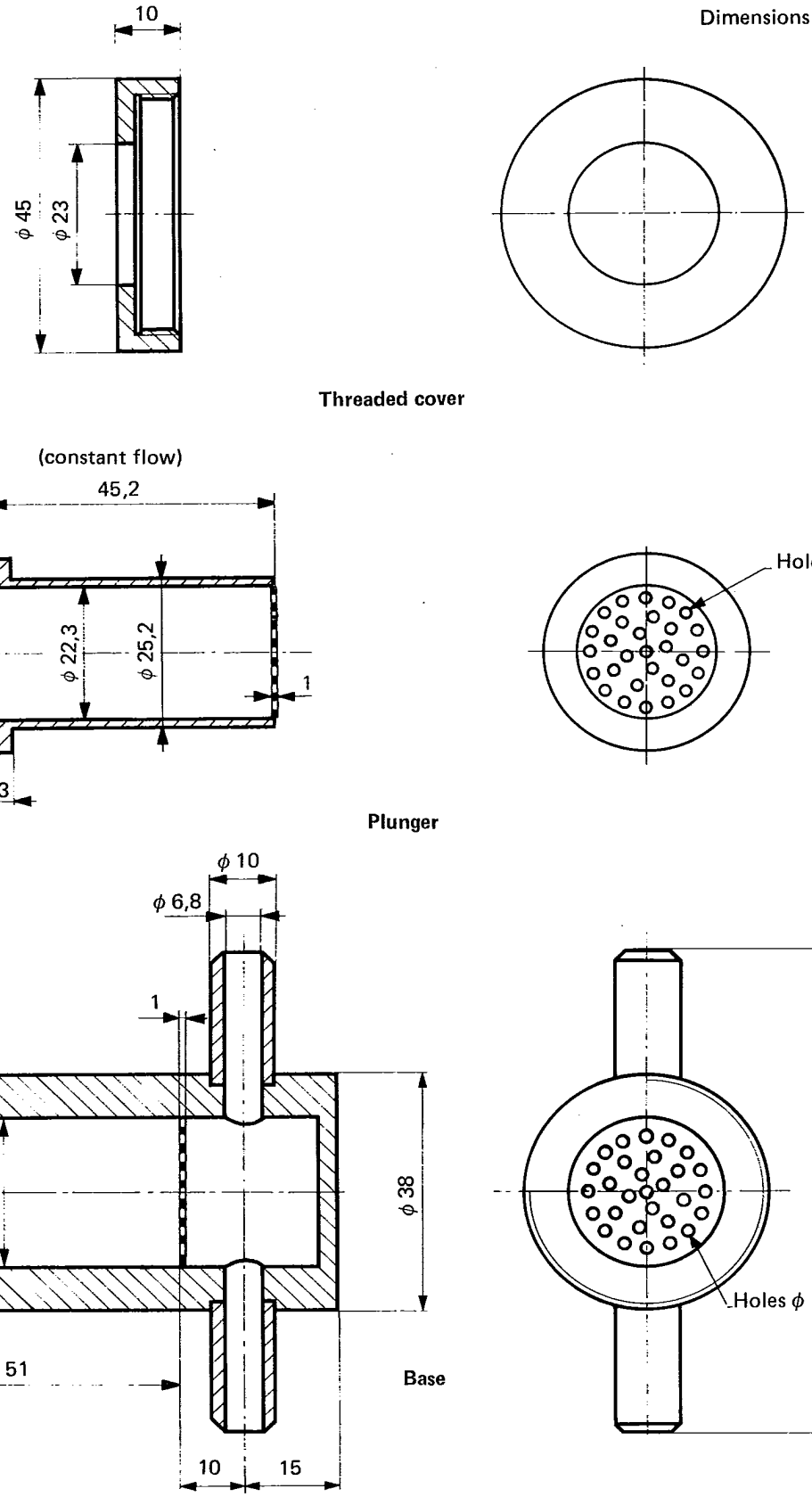


Figure 5 — Measuring chamber with constant volume A

6.5 Procedure

Start up the pump and adjust the air flow to 250 cm^3/s by means of the tap. Check the "zero" on the gauge and adjust if necessary.

Introduce into the chamber of the equipment, as evenly as possible, the previously weighed test piece, containing randomly oriented or fully disoriented fibres, ensuring a homogeneous filling density. Compress the fibre slightly with the fingers, then introduce the plunger which completes the compression.

Screw on the cover until the flange of the plunger makes contact with its seat in the chamber; this condition is imperative in order to define correctly the volume occupied by the specimen.

After about 10 s, if necessary, regulate the air flow to 250 cm^3/s and read the difference in level $\triangle h_1$ on the gauge.

Then withdraw the test piece, open again with the fingers, turn 180° around its horizontal axis and put again into the chamber for a new operation. Again read the difference in level $\triangle h_2$.

Repeat this operation and carry out a third reading of the difference in level $\triangle h_3$.

6.6 Control of apparatus functioning

It is recommended that two gauges be used for regular control of the apparatus and verification that it is in good working condition. These gauges consist of pieces of metal, of diameter equal to the internal diameter of the constant volume chamber, with a central hole. Each disk presents one side which rests, when in use, on the upper annular part of the constant volume chamber.

The diameter of the central hole of one of the disks shall be chosen to give a reading of approximately 1/3 of the measurement scale of the manometer, when the disk is placed on the apparatus, the latter being used as when a measurement of fineness is made, but without fibre in the chamber.

The diameter of the central hole of the second disk shall be chosen to give a reading corresponding to approximately 2/3 of the measurement scale of the manometer.

About once per day, place the gauges in the apparatus, passing air through the central hole only, and note the corresponding readings.

The variations in these readings should not exceed, depending on the gauges being used, 2 or 3 mm of the scale. This procedure forms a useful and rapid check of the functioning of the apparatus, especially in respect of the penetration of air into it.

6.7 Calculation and expression of results

Take the mean value $\triangle h$ of the three readings of difference in level $\triangle h_1$, $\triangle h_2$, $\triangle h_3$ obtained for each specimen.

Calculate the mean D of the $\triangle h$ values obtained for the five specimens.

Express the result in centimetres to one decimal place.

The parameter D is characteristic of the fineness; however, by convention, the value of D shall be used as described in annex B to enable the results to be expressed as an index of fineness standard, IFS.

7 Test report

The test report shall include the following particulars :

a) a reference to this International Standard;

b) the standard atmosphere used (temperate or tropical);

c) the results obtained;

d) the method of measurement used;

e) details of any operations not included in the method used;

f) any possible incidents which may have affected the results.

Annex A

Carding of flax tow in wads

A.1 Apparatus

The apparatus shown in figure 6 comprises :

1) A fixed portion B, placed on a horizontal table, consisting of a small board to which is fastened a piece of card clothing.

2) A moving portion A, held in the hand at m, consisting of a small board provided with a piece of card clothing on which the pins are arranged in such a fashion that when A is applied to B and the operator draws A towards himself, a carding action results.

The card clothing on B has attached to it a guiding system S, preventing interlocking of the pins on A and B and keeping their points about 2 to 3 mm apart.

The two vertical members S′ constrain portion B, assuring guidance of portion A.

Figure 6 shows how the pins are arranged and indicates their characteristics.

A.2 Procedure

A.2.1 Alignment by carding

A.2.1.1 Take 13 to 15 g of flax tow and spread it on portion B of the apparatus. Engage A on B at the back end and slide A by pulling it towards oneself until it disengages; at this moment the material is divided into two parts. Repeat the movement until the majority of the fibres on B are parallel.

A.2.1.2 Lift the material adhering to portion A and place this web A on the table. Lift the material adhering to portion B and place this web B on the fixed portion B after rotation through 180° around the longitudinal axis of the apparatus. Carry out the carding process as described in A.2.1.1.

A.2.1.3 Two new webs are obtained :

— BB (produced from web B and adhering to B) treated on both sides. Carding is finished for this web.

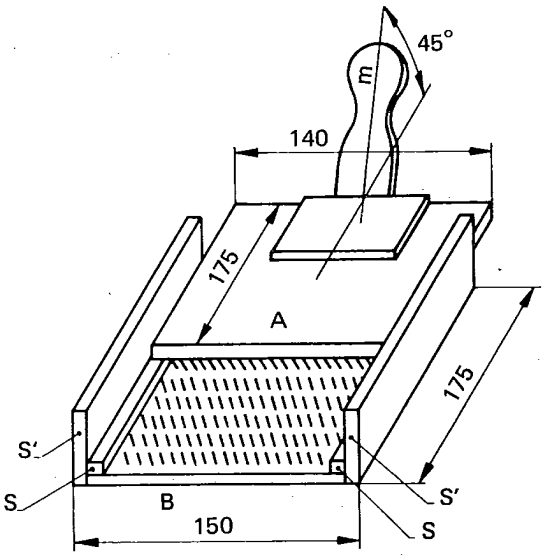
— BA (produced from web B and adhering to A). In certain cases the straightening is sufficient at this stage and the carding of BA is not necessary.

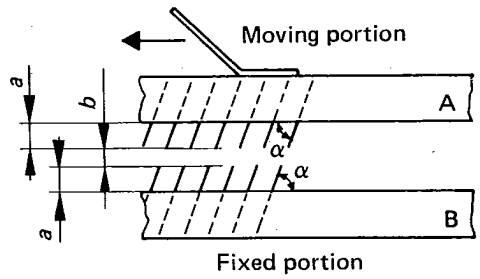
A.2.1.4 In other cases, place the web BA on the portion B, with the side treated by part A turned towards the pins of portion B. Carry out the carding process as described in A.2.1.1. This carding gives two new webs BAB and BAA.

A.2.1.5 Take web A (see A.2.1.2) and repeat the procedures undertaken on web B.

The following six webs are thus obtained : "BB", "BAB", "BAA", "AB", "AAB" and "AAA".

Dimensions in millimetres





$a = 7$
$b = 2$ to 3
$\alpha = 70°$

Pins :

diameter at the base :	1,2
total length :	20,0
arrangement per square centimetre :	

Figure 6 — Carding apparatus

A.2.2 Preparation of test specimen

Superimpose the six webs, with the fibres orientated in the same direction. Fold the mat of fibres over, following the symmetric axis parallel to the fibres. Take one of the edges of the mat in one hand, and the other edge in the other hand and pull gently, parallel to the axis of the mat, until the fibres held in the hand are extracted.

Replace these two parts on top of each other and repeat the extraction process until sufficient straightening is achieved. Take care at the same time to standardize the centre of the tuft. Cut out an 80 mm tuft from the middle section, for the measurement of fineness.

Annex B

Standardization of apparatus

B.1 Samples of flax

Obtain a sufficient quantity of reference material (see annex D) to provide five specimens.

B.2 Establishment of the conversion equation

B.2.1 The relation between the parameters A' or D of IFS is not linear. The most simple manner of linearising these relations is to consider the relation :

$\frac{10}{A'}$ and IFS, or $\frac{1\,000}{D}$ and IFS.

B.2.2 Adjusting the results by the method of least squares,

$X = \frac{10}{A'}$ and Y = IFS for the reference method;

$X = \frac{1\,000}{D}$ and Y = IFS for the simplified method.

The relation between X and Y may be considered as linear within the limits of the reference batch; it suffices to determine the equation from the assumption $Y = aX + b$.

B.2.3 The process of calculation is as follows.

Taking n pairs of values X_1, Y_1 corresponding to n reference batches available :

$X_1, X_2, X_3, \ldots, X_i, \ldots, X_n$

$Y_1, Y_2, Y_3, \ldots, Y_i, \ldots, Y_n$

proceed to calculate the following :

$$X = \sum_{i=1}^{n} X_i = X_1 + X_2 + \ldots X_i \ldots + X_n$$

$$Y = \sum_{i=1}^{n} Y_i = Y_1 + Y_2 + \ldots Y_i \ldots + Y_n$$

$$A = \sum_{i=1}^{n} X_i Y_i = X_1 Y_1 + X_2 Y_2 + \ldots X_i Y_i \ldots + X_n Y_n$$

$$B = \sum_{i=1}^{n} X_i^2 = X_1^2 + X_2^2 + \ldots X_i^2 \ldots + X_n^2$$

One deduces :

$$a = \frac{XY - nA}{X^2 - nB} \text{ and } b = \frac{XA - YB}{X^2 - nB}$$

B.2.4 The application of this equation to each apparatus leads to the following relationship :

$$\text{index of fineness (IFS)} = a \times \frac{10}{A'} + b \text{ or } a \times \frac{1\,000}{D} + b$$

Annex C

Kozeny equation

(This annex does not form part of the standard.)

The Kozeny equation is an equation connecting the resistance to the passage of air of a wad, to the specific surface A when a flow of air with laminary movement is produced across the wad. It can be set down as follows :

$$R = \frac{(1 - \epsilon)^2 L}{\epsilon^3 \quad \omega} \mu k A^2$$

where

ϵ is the porosity of the wad; quotient of the volume of the space in the wad by the volume of the central channel of the casing, given by the formula

$$1 - \frac{m}{\varrho \omega L}$$

m being the mass of the wad, in grams;

ϱ being the density of fibrous substance, in grams per cubic centimetre;

ω being the section of the central channel of the casing, in square centimetres;

L being the length of the casing in centimetres;

μ is the dynamic viscosity of the air, in centinewton seconds per square centimetre;

k is a dimensionless empirical factor of proportionality;

A is the specific surface of the wad in square centimetres per cubic centimetre.

If the mass of the wad and the size of the channel of the casing of the equipment are known (ϵ, L, ω known), the Kozeny equation shows that, in these conditions, the resistance R of the wad is proportional to $\mu k A^2$.

It is accepted that for a certain field of porosity, k is approximately constant. In this field of porosity (in which the measurements are made) and with relatively constant temperature and humidity of the air, μ is also approximately constant.

In these conditions the resistance to the passage of the air is proportional to the square of the specific surface A of the fibres of the wad.

To avoid having to calculate k and μ, the specific surface index $A' = A\sqrt{\mu k}$ is used.

In the reference method, the same wad is measured with two slightly different porosities, which makes it possible to calculate not only A' but also the density of the substance.

Annex D

Reference flax

(This annex does not form part of the standard.)

A range of ten batches of flax with characteristics determined by the two methods of test and with an indication of the index of fineness standard can be obtained from ITF-Nord, Rue de la Recherche, BP 37, 59650 Villeneuve d'Ascq-Flers, France.