INTERNATIONAL STANDARD

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Footwear — Test methods for uppers, lining and insocks — Thermal insulation

Chaussures — Méthodes d'essai des tiges, de la doublure et des premières de propreté — Isolation thermique

Reference number
ISO 17705:2003(E)

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 17705 was prepared by CEN (as EN 13521:2001) and was adopted, under a special “fast-track procedure”, by Technical Committee ISO/TC 216, *Footwear*, in parallel with its approval by the ISO member bodies.

For the purposes of international standardization, a list of corresponding International and European Standards for which equivalents are not given in EN 13521 has been added as Annex ZZ.

Contents

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 309 "Footwear", the secretariat of which is held by AENOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2002, and conflicting national standards shall be withdrawn at the latest by May 2002.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

EN 13521:2001 (E)

1 Scope

This European Standard specifies a test method for determining the thermal conductivity of uppers, lining and insocks irrespective of the material, in order to assess the suitability for the end use.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 12222 *Footwear - Standard atmospheres for conditioning and testing of footwear and components for footwear.*

3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply.

3.1
thermal insulation
thermal conductivity of a material under static conditions

3.2
upper
materials forming the outer surface of the footwear which is attached to the sole assembly and covers the upper dorsal surface of the foot. In the case of boots this also includes the outer face of the material covering the leg. Only the materials that are visible are included, no account should be taken of underlying materials

3.3
complete upper assembly
finished upper, fully seamed, joined or laminated as appropriate, comprising the centre material and any lining(s) together with all components such as interlinings, adhesives, membranes, foams or reinforcements, but excluding toe puffs and stiffeners

NOTE The complete upper assembly can be flat, 2-dimensional or comprise lasted upper in the final footwear.

4 Apparatus and material

The following apparatus and material shall be used:

4.1 "Lees' disc" apparatus, see Figure 1, including the following:

4.1.1 Cylindrical brass block, which will subsequently be referred to as block B1, with:

4.1.1.1 Diameter of approximately 75 mm which is known with an accuracy of 0,2 mm.

4.1.1.2 Height of approximately 25 mm which is known with an accuracy of 0,2 mm.

4.1.1.3 Hole of diameter 2 mm ± 0,1 mm drilled radially to its centre.

4.1.1.4 Type K thermocouple inserted into the hole until its junction is at the bottom of the hole.

4.1.1.5 Remaining volume of the hole shall be filled with a high thermal conductivity compound with a thermal conductivity of better than 0,8 W/(m °C), for example a metal oxide filled paste of the type used between high power semiconductor electronic devices and heat sinks.

4.1.2 Circular electrical heater element which:

4.1.2.1 Has a diameter the same as that of the blocks in 4.1.1, with a tolerance of ± 0,5 mm.

4.1.2.2 Is capable of dissipating a minimum power density of 400 W/m^2 from each of its circular faces.

4.1.2.3 Has a cylindrical brass block and thermocouple of the same dimensions as block B1 bonded to both its top and bottom faces with a high thermal conductivity adhesive compound. These two blocks will subsequently be referred to as B2 and B3.

4.1.3 A fourth cylindrical brass block fitted with a thermocouple as in 4.1.1 of the same diameter as block B1 but of height (8 ± 2) mm. This is for measuring the ambient temperature of the surrounding atmosphere and will subsequently be referred to as block B4.

4.1.4 A power supply unit connected to the heater element (4.1.2). The unit should be capable of supplying sufficient power to enable the heater element to dissipate a power density of 400 W/m^2 from each of its circular faces.

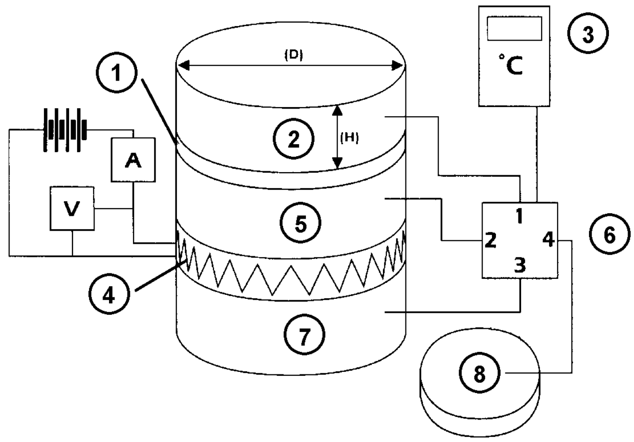
4.1.5 Means of measuring the power being supplied to the heater element to an accuracy of ± 4 mW.

4.1.6 Means of mounting the heater and block assembly so that air can circulate freely around all the outside edges of the assembly.

4.1.7 Device capable of measuring and displaying the temperatures of the thermocouples in the four brass cylindrical blocks to an accuracy of ± 0,2 °C.

4.2 **Circular press knife or similar device for cutting** circular test specimens of the same diameter as the block B1, with a tolerance of ± 0,5 mm.

4.3 **Dial thickness gauge** which applies a pressure of (2,0 ± 0,2) kPa to the test specimen and is capable of measuring to the nearest 0,01 mm.



Key

1 Test specimen
2 Block B1
3 Temperature display
4 Heater
5 Block B2
6 Switching device
7 Block B3
8 Block B4

Figure 1 — Lees' disc thermal conductivity apparatus

5 Sampling and conditioning

5.1 Store the uncut sheet material in a conditioned standard atmosphere as specified in EN 12222 for at least 48 h prior to cutting test specimens.

5.2 Cut two circular test specimens of the same diameter as the metal block B1, with a tolerance of ± 0,5 mm.

NOTE Test specimens can be taken either from materials likely to be used for uppers and linings or from made-up uppers or finished footwear. Prepare test specimens from complete upper assemblies when the lining material is permanently attached to the upper material.

6 Test method

6.1 Principle

A constant heat source is sandwiched between two identical metal cylinders which are mounted with their axes vertical. A test specimen is placed on the top surface of the upper cylinder and a third identical metal cylinder is placed on top of the test specimen so that all the cylinders and the test specimen are concentrically aligned. The heat source is switched on and the temperatures of the three blocks allowed to reach equilibrium. The thermal conductivity of the test specimen is then determined from the steady state temperatures of the three blocks, the exposed surface areas of the blocks and test specimen and the thickness of the test specimen.

6.2 Procedure

6.2.1 Use the thickness gauge (4.3) to measure the thickness *S*, in mm, at the centre of each test specimen and record these two values to the nearest 0,05 mm.

6.2.2 Ensure that the heater assembly (4.1.2) is mounted vertically so that block B2 is above block B3, see Figure 1. Place the apparatus in a temperature controlled atmosphere as specified in EN 12222 and position it so that air can circulate freely around the assembly.

6.2.3 Place one of the test specimens onto the upper surface of block B2 and carefully rest the block B1 on top of the test specimen. The surface of the test specimen which will be nearest the foot shall be placed against block B2 so that it is closest to the heater element. Adjust the positions of the block B1 and the test specimen until they are both concentrically aligned with the heater assembly (4.1.2).

6.2.4 Switch on the power supply unit (4.1.4) and adjust until it is delivering sufficient power to heat the brass cylindrical blocks, B2 and B3, to a steady state temperature of 35 °C ± 5 °C.

NOTE Typically a current of 0,14 A at a voltage of 18 V is required to achieve a steady state temperature of 35 °C ± 5 °C.

6.2.5 At regular intervals of approximately 30 min record the temperature of the four blocks B1, B2, B3 and B4 to the nearest 0,2 °C.

6.2.6 When three sets of successive readings are found to be within ± 0,2 °C for each block then the test shall be terminated. Record the temperatures, in ºC, of the four blocks as TE_1, TE_2, TE_3 and TE_4 respectively. Remove the test specimen and block B1 from the heater assembly (4.1.2) and repeat the procedure in 6.2.3 to 6.2.6 for the other test specimen.

7 Expression of results

7.1 Calculate the exposed area, in square metres (m^2), of blocks B1, B2 and B3 using:

Exposed area of block B1 = A1 = $\pi \cdot D \cdot [(0,25 \cdot D) + H]$

Exposed area of block B3 = [A3] = $\pi \cdot D \cdot [(0,25 \cdot D) + H]$

Exposed area of block B2 = [A2] = $H \cdot \pi \cdot D$

where

A is the exposed area, in square metres (m^2);

D is the diameter of blocks as in 4.1.1.1 and 4.1.2.3, in metres (m);

H is the height of blocks as in 4.1.1.2, in metres (m).

NOTE All diameter and height measurements are converted from mm to m by dividing them by 1 000.

7.2 For each test specimen calculate:

7.2.1 Exposed area, in square metres (m^2), of test specimen using:

Exposed area of test specimen = $A_s = S \cdot \pi \cdot D$

where

S is the thickness of test specimen measured in 6.2.1, in metres (m);

D is the diameter of test specimen (see 5.2), in metres (m).

7.2.2 Power, in watts, supplied to heater using:

Power supplied = $P = V \cdot I$

where

V is the voltage supplied to heater, in volts (V);

I is the current supplied to the heater, in amperes (A).

7.2.3 The temperatures, in °C, of blocks B1, B2, and B3 above ambient as:

$T_1 = TE_1 - TE_4$

$T_2 = TE_2 - TE_4$

$T_3 = TE_3 - TE_4$

7.2.4 The average temperature, in °C, of the test specimen, T_s, where:

$T_s = 0{,}5 \cdot (T_1 + T_2)$

7.2.5 The thermal conductivity of the test specimen, K, in watts per metre per degree Celsius (W/m °C) using:

$K = P \cdot S \cdot (A_s \cdot T_s + 2 \cdot A_1 \cdot T_1) /$

$[((A_1 \cdot T_1 + A_s \cdot T_s + A_2 \cdot T_2 + A_3 \cdot T_3) \cdot (0{,}5 \cdot \pi \cdot D^2 \cdot (T_2 - T_1))]$

7.3 Calculate the arithmetic mean of the two values of thermal conductivity, K_a, to three significant figures.

7.4 Calculate the average thermal resistance of the test specimens, R, in square metres degree Celsius per watt (m^2 °C/W) from the arithmetic mean of the thermal conductivities using the equation:

Thermal resistance = S_a / K_a

where

S_a is the arithmetic mean thickness of the two specimens, in metres (m);

K_a is the arithmetic mean thermal conductivity, in watts per metre per degree Celsius (W/m ºC).

8 Test report

The test report shall include the following information:

a) the arithmetic mean thermal conductivity as calculated in 7.3;

b) the average thermal resistance as calculated in 7.4;

c) a description of the material including commercial references (style codes, etc.);

d) a description of any lining or other reinforcement present;

e) reference to the method of test;

f) the pressure on the test specimen (derived from mass of block B1 and surface area of block);

g) date of testing;

h) any deviations from this test method.