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Protective clothing — Protection against heat and fire — Method of test: Evaluation of materials and material assemblies when exposed to a source of radiant heat

Vêtements de protection — Protection contre la chaleur et le feu — Méthode d'essai: Évaluation des matériaux et assemblages des matériaux exposés à une source de chaleur radiante

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 94, *Personal safety — Personal protective equipment*, Subcommittee SC 13, *Protective clothing*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 162, *Protective clothing including hand and arm protection and lifejackets,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This fourth edition cancels and replaces the third edition (ISO 6942:2002), which has been technically revised.

The main changes are as follows:

— normative references have been updated (see Clause 2);

— the specified relative humidity range for the conditioning atmosphere has been changed (see 7.1);

— an example product for the optically black paint has been provided (see 5.4);

— the annex on ILT has been revised (Annex A).

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

Protective clothing against radiant heat is worn at different occasions and accordingly the radiation intensity (characterised by the heat flux density) acting on the clothing material extends over a wide range. This document describes two test methods which can be applied to all sorts of materials, but, according to the intended use of the material, the heat flux density has to be chosen properly and the results have to be interpreted correctly,

Industrial workers or fire fighters may be exposed to a relatively low radiation intensity over a long period of time. On the other hand, industrial workers or fire fighters may be exposed to medium radiation intensities for relatively short periods of time or to high radiation intensities for very short periods of time. In the latter case, the clothing material may be changed or even destroyed.

The materials for protective clothing are usually tested at medium and high heat flux densities. The response of materials to method A and the times t_{12} and t_{24} and transmission factor measured with method B characterise the material. For information on the precision of method B, see Annex A.

Protective clothing — Protection against heat and fire — Method of test: Evaluation of materials and material assemblies when exposed to a source of radiant heat

1 Scope

This document specifies two complementary methods (method A and method B) for determining the behaviour of materials for heat protective clothing subjected to heat radiation.

These tests are carried out on representative single or multi-layer textiles or other materials intended for clothing for protection against heat. They are also applicable to assemblies, which correspond to the overall build up of a heat protective clothing assembly with or without underclothing,

Method A serves for visual assessment of any changes in the material after the action of heat radiation. With method B the protective effect of the materials is determined. The materials may be tested either by both methods or only by one of them.

The tests according to these two methods serve to classify materials; however, to be able to make a statement or prediction as to the suitability of a material for protective clothing additional criteria must be taken into account.

Since the tests are carried out at room temperature the results do not necessarily correspond to the behaviour of the materials at higher ambient temperatures and therefore are only to a limited extent suitable for predicting the performance of the protective clothing made from the materials under test.

2 Normative reference

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/TR 11610, *Protective clothing — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TR 11610 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
Heat transfer levels

3.1.1
time t_{12}
time in seconds expressed to one decimal place, to achieve a calorimeter temperature rise of (12 ± 0,1) °C when tested according to method B

3.1.2
time t_{24}
time in seconds expressed to one decimal place, to achieve a calorimeter temperature rise of (24 ± 0,2) °C when tested according to method B

3.2
heat transmission factor
TF
measure of the fraction of heat transmitted through a specimen exposed to a source of radiant heat. It is numerically equal to the ratio of the transmitted to the incident heat flux density

3.3
test specimen
all layers of fabric or other material arranged in the order and orientation as used in practice and including undergarments if appropriate

3.4
incident heat flux density
amount of energy incident per unit time on the exposed face of the calorimeter

Note 1 to entry: The incident heat flux density is expressed in kW/m^2.

3.5
radiant heat transfer index
RHTI
number, calculated from the mean time (measured in seconds, to one decimal place) to achieve a specified temperature rise in the calorimeter when testing by this method with a specified *incident heat flux density* (3.4)

3.6
change in appearance of the specimen
all changes in appearance of the material (shrinkage, formation of char, discoloration, scorching, glowing melting, etc.).

3.7
multi-layer clothing assembly
series of layers in garments arranged in the order as worn

Note 1 to entry: It may contain multi-layer materials, material combinations or separate layers of clothing material in single layers.

4 Principle

4.1 Method A

A specimen is supported in a free-standing frame (specimen holder) and is exposed to a specific level of radiant heat for a specific time. The level of radiant heat is set by adjustment of the distance between the specimen and the thermal radiation source. Following the exposure, the specimen and its individual layers, are examined for visible changes.

4.2 Method B

A specimen is supported in a free-standing frame (specimen holder) and is exposed to a specific level of radiant heat. The times for temperature rises of 12 °C and 24 °C in the calorimeter are recorded and are expressed as radiant heat transfer indexes. The percentage heat transmission factor is calculated from the temperature rise data and is also reported.

5 Apparatus

5.1 General

The test apparatus consists of the following items, which are used for both test methods:

— source of radiation (see 5.2);

— test frame (see 5.3);

— specimen holder (see 5.3).

For method B, the following are also required:

— calorimeter (see 5.4);

— temperature measuring and recording device (see 5.5).

5.2 Source of radiation

The radiation source consists of six silicon carbide (SiC) heating rods, with the following characteristics:

— total length: (356 ± 2) mm;

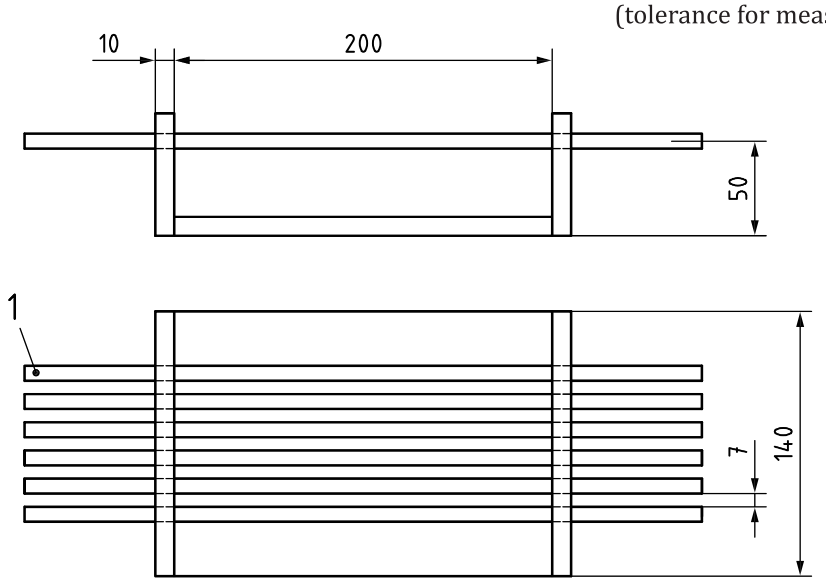
— length of heating part: (178 ± 2) mm;

— diameter: (7,9 ± 0,1) mm;

— electrical resistance: 3,6 Ω ± 10 % at 1 070 °C.

These rods are placed in a U-shaped support made of insulating, flame resistant material so that they are arranged horizontally and in the same vertical plane. Figure 1 shows the constructional details of the support and the arrangement of the heating rods, which are loosely mounted in the grooves of the support to avoid mechanical stress.

Dimensions in millimetres
(tolerance for measurements ±0,1 mm)

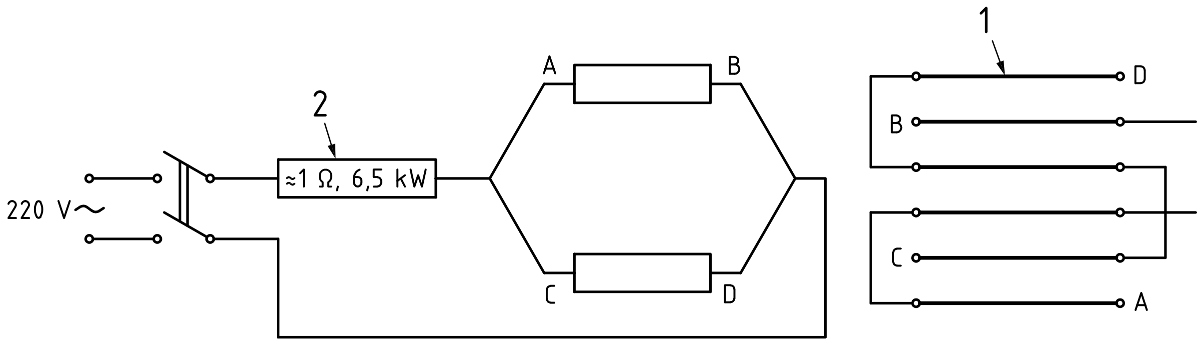


Key

1 silicon carbide rod

Figure 1 — Source of radiation

A diagram of a possible power supply for the radiation source is shown in Figure 2. The six rods are arranged into two groups of three, placed in series. The two groups are connected in parallel and are wired to the 220 V supply through a pre-resistance of 1 Ω. For other supply voltages, the circuit has to be changed accordingly. If the supply voltage fluctuates by more than ±1 % during a measurement, stabilisation has to be provided.



Key

1 silicon carbide rod

2 pre-resistance

Figure 2 — Circuit diagram for heating rods

The electrical connections of the heating rods shall be made carefully (e.g. by means of a stranded aluminium band), taking into consideration that the rods become very hot. Precautions shall be taken to avoid short circuits between the rods.

The correct operation of the radiation source shall be checked by using an infrared thermometer to measure the temperature of the silicon carbide rods. After allowing the radiation source to warm up for 5 min, the rods should have reached a temperature of about 1 100 °C.

5.3 Specimen holder

Different specimen holders are used for methods A and B. They are constructed from 2 mm thick steel sheets fixed to a 10 mm thick aluminium plate. The specimen holder for method A has wider side plates than the specimen holder for method B. The specimen holder for method B also holds the calorimeter in position.

The specimen holders are fastened so that they fit concentrically into the opening of the vertical of the test frame. When fixed in position, the specimen holder for method A hold the back of the specimen 10 mm behind the sheet metal cover at the front of the test frame. The specimen holder for method B holds the vertical centre line of the calorimeter 10 mm behind the sheet metal cover at the front of the test frame.

5.4 Calorimeter

The curved copper plate calorimeter is constructed as follows.

A rectangle (50 mm by 50,3 mm) is cut from a copper sheet of at least 99 % purity and 1,6 mm thick. This copper plate is bent in the longer direction into an arc with a radius of 130 mm. The chord across this arc should be ~50 mm. The copper plate should be accurately weighed before assembly and should have a mass of 35,9 g to 36 g.

A copper constantan thermocouple, with an output in millivolts complying with IEC 60584-1, is mounted on the back of the copper plate. Both wires should be attached to the centre of the plate using the minimum amount of solder. The diameter of both wires should be 0,26 mm or less and only the length attached to the plate should be bared.

The calorimeter is located in a mounting block which shall consist of a 90 mm by 90 mm square piece of asbestos-free non-combustible, heat insulation board of nominal thickness 25 mm. The thermal characteristics of the board should comply with the following specification:

— density: (750 ± 50) kg/m^3;

— thermal conductivity: 0,18 W/(m·K) ± 0,018 W/(m·K).

A triangular wedge is removed from two opposite sides of the top of this block, so that the two sides are reduced to a height of 21 mm. Two further triangular wedges are removed from 20 mm in from each of the lowered sides, to further reduce them to a height of 17 mm. This gives a top surface with four flat faces, which corresponds very closely to the curved surface which would be obtained by grinding the top surface into an arc of 130 mm radius (see Figure 3).

A rectangular hole is cut in the centre of the top of the board. The hole shall be 50 mm across parallel to the lowered sides and 46 mm across parallel to the shaped sides. The hole shall have a flat bottom and shall be 10 mm deep along the lower edges and approx. 12 mm deep in the centre. An edge, 1 mm deep by 2 mm wide, is cut along the two lower edges of the rectangular hole for mounting the curved copper plate. A 3 mm diameter circular hole is cut in the centre of the rectangular hole for passing the thermocouple wires.

The curved copper plate is bonded to the mounting block around its edges using an adhesive capable of withstanding temperatures of about 200 °C. The top of the copper plate should be 0,6 mm higher than the mounting block along the two straight edges and higher than the mounting block along the two curved edges. The mounting block should be higher than the bottom of the copper plate along its curved edges.

The calorimeter is mounted into the combined specimen/calorimeter holder B.

The face of the calorimeter shall be coated with a thin film of an optically black paint having a coefficient of absorption, α, greater than 0,9.

NOTE “NEXTEL Velvet Coating 811-21 9218 black” has been found to be suitable as an optically black paint.

