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Solar energy — Collector components and materials —

Part 5: Insulation material durability and performance

Énergie solaire — Composants et matériaux du collecteur — Partie 5: Durabilité et performance des matériaux isolants

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established 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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 180, *Solar Energy.*

A list of all parts in the ISO 22975 series can be found on the ISO website.

Introduction

The insulation material is a component of a solar collector, which is placed behind the panel in a flat plate solar collector or in the header of an evacuated tube solar collector through a specific filling process and is used as a heat insulation element.

This document provides test methods for measuring the common properties on insulation materials, including apparent density, apparent volume percentage of open cells of PU and PF, and dimension, bulk density of MW and mineral fibre. For each test, this document specifies sampling, apparatus and acceptance test procedure.

This document also provides test methods for determining the durability of insulation materials, including compression properties, water absorption, hygroscopic sorption properties, water vapor transmission properties, flammability, accelerated aged value of thermal resistance of PU and PF, and compression behaviour, water absorption, moisture content, water vapor transmission properties, maximum use temperature, non-combustibility of MW and mineral fibre. For each durability test, this document specifies principle, apparatus, sampling, acceptance test procedure, calculation and expression of results, or evaluation.

This document also provides test methods and acceptance test procedure for measuring performance of insulation materials, including thermal resistance and thermal conductivity.

This document also provides test methods and acceptance test procedure for measuring outgassing of insulation materials in solar flat-plate collector.

Solar energy — Collector components and materials —

Part 5: Insulation material durability and performance

1 Scope

This document specifies the requirements on insulation materials for solar collectors and test methods for durability and performance of insulation materials used in solar collectors.

This document is applicable to all types of insulation material used in solar collectors, such as rigid polyurethane foam (PU), phenolic foam (PF), mineral wool (MW) and mineral fibre.

2 Normative references

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 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 844, *Rigid cellular plastics — Determination of compression properties*

ISO 845, *Cellular plastics and rubbers — Determination of apparent density*

ISO 1182:2010, *Reaction to fire tests for products — Non-combustibility test*

ISO 1663, *Rigid cellular plastics — Determination of water vapour transmission properties*

ISO 2796, *Cellular plastics, rigid — Test for dimensional stability*

ISO 2896, *Rigid cellular plastics — Determination of water absorption*

ISO 4590, *Rigid cellular plastics — Determination of the volume percentage of open cells and of closed cells*

ISO 8301, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Heat flow meter apparatus*

ISO 9050, *Glass in building — Determination of light transmittance, solar direct transmittance, total solar energy transmittance, ultraviolet transmittance and related glazing factors*

ISO 11561:1999, *Ageing of thermal insulation materials — Determination of the long-term change in thermal resistance of closed-cell plastics (accelerated laboratory test methods)*

ISO 11925-2, *Reaction to fire tests — Ignitability of products subjected to direct impingement of flame — Part 2: Single-flame source test*

ISO 12570, *Hygrothermal performance of building materials and products — Determination of moisture content by drying at elevated temperature*

ISO 12571, *Hygrothermal performance of building materials and products — Determination of hygroscopic sorption properties*

ISO 29469, *Thermal insulating products for building applications — Determination of compression behaviour*

3 Terms and definitions

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

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

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

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

3.1
bulk density
mass per unit volume of uncompact filling insulation material

Note 1 to entry: Bulk density is expressed in kilograms per cubic metre (kg/m^3).

3.2
water vapour transmission rate
g
quantity of water vapour transmitted through unit area in unit time under specified conditions of temperature, humidity and thickness

3.3
water vapour permeance
W
quotient of the *water vapour transmission rate* (3.2) of the test specimen and the water vapour pressure difference between the two specimen faces during the test

3.4
water vapour resistance
Z
inverse of *water vapour permeance* (3.3)

3.5
water vapour permeability
δ
quantity of water vapour transmitted per unit of time through a unit area of the product per unit of vapour pressure difference between its faces for a unit thickness

3.6
water vapour diffusion resistance factor
μ
quotient of the *water vapour permeability* (3.5) of air and the *water vapour permeability* (3.5) of the material or the homogeneous product concerned

Note 1 to entry: *μ* indicates the relative magnitude of the water vapour resistance of the product and that of an equally thick layer of stationary air at the same temperature.

3.7
water vapour diffusion equivalent air layer thickness
S_d
thickness of a motionless air layer which has the same water vapour resistance as the test specimen with the thickness, *d*

3.8
maximum use temperature
highest temperature that can be borne by the material under the normal usage condition

Note 1 to entry: Maximum use temperature is expressed in degrees Celsius (°C).

4 Requirements

4.1 General

Product properties of the insulation materials used in solar collectors shall be given by the manufacturers. Product properties should be assessed in accordance with Clause 5. To comply with this document, products should meet the situation of 4.2 as appropriate.

4.2 For specific application

For specific application and quality control, in the cases of being agreed by the purchaser and seller, acceptable performance of insulation materials may be considered as the recommended performance levels provided in Annex B.

5 Test methods

5.1 Rigid polyurethane foam and phenolic foam

5.1.1 Standard atmospheres for conditioning and testing

They shall be in accordance with ISO 291.

5.1.2 Apparent density

It shall be in accordance with ISO 845.

5.1.3 Apparent volume percentage of open cells

It shall be in accordance with ISO 4590.

5.1.4 Dimensional stability

It shall be in accordance with ISO 2796.

5.1.5 Compression properties

They shall be in accordance with ISO 844.

5.1.6 Water absorption

It shall be in accordance with ISO 2896.

5.1.7 Hygroscopic sorption properties

They shall be in accordance with ISO 12571.

5.1.8 Water vapor transmission properties

They shall be in accordance with ISO 1663.

5.1.9 Thermal resistance and thermal conductivity

They shall be in accordance with ISO 8301.

5.1.10 Flammability

It shall be in accordance with ISO 11925-2.

5.1.11 Accelerated aged value of thermal resistance

It shall be in accordance with ISO 11561.

5.2 Mineral wool and mineral fibre

5.2.1 Dimension

5.2.1.1 Sampling

The number of specimens and sampling shall be as follows:

1) A test sample shall consist of one representative roll or package of insulation.

2) Sampling of packages — For packages which contain 20 or more batts, five batts shall be selected. For packages which contain less than 20 batts, either the three-batt or five-batt selection technique may be used. Batts which are folded in half shall count as two batts for purposes of choosing and employing the selection method.

   a) Three-Batt Method — Select the centre batt and the second batt from each end of the package.

   b) Five-Batt Method — Divide the package sequentially into five groups of batts as equal in number as possible. Select the first batt from each group. Be careful to select one and only one batt from the two end batts within the package.

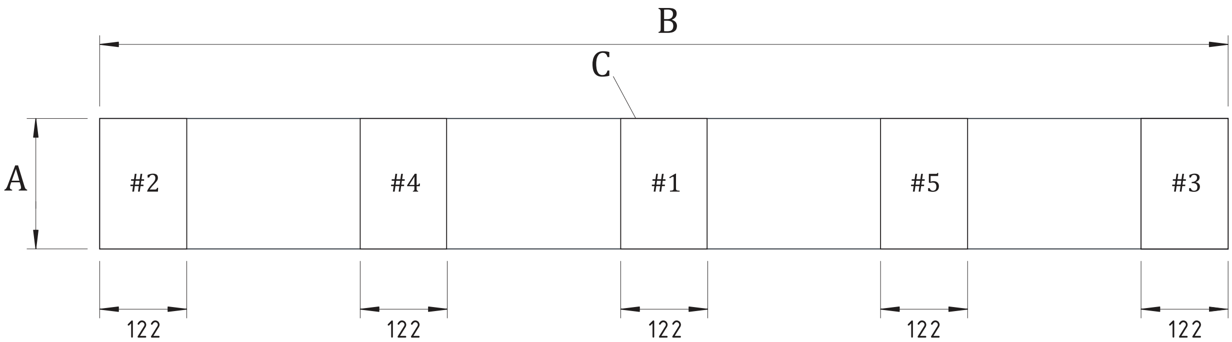
   c) Cut batts which are longer than (122 ± 0,63) cm in length.

3) Sampling of cut rolls — Five batts shall be cut of roll-width by (122 ± 0,63) cm in length.

   a) Cut one batt from the centre of the roll, two batts from the ends of the roll, and the fourth and fifth from the quarter points along the length. See Figure 1.

   b) For blankets wider than 61 cm, cut each of the five batts (61 ± 0,63) cm wide by (122 ± 0,63) cm long.

Dimensions in centimetres



Key

A nominal roll width

B nominal roll length

C batt

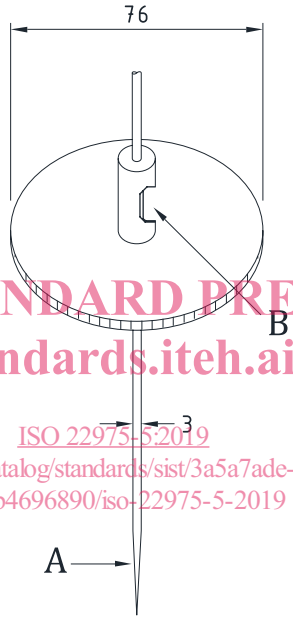
Figure 1 — Sampling of cut rolls

4) Sampling for Full Roll Method — This method can be used in place of sampling of cut rolls when the roll is wider than 61 cm or longer than 16,4 m. Prior to unrolling the material, weigh the entire roll to the nearest 0,11 kg. Two methods may be used to obtain the full roll weight. The first method removes the insulation product from the packaging prior to weighing. The material will expand and can unroll slightly, care shall be taken to ensure that the full roll is weighed accurately. The second method weighs the packaged insulation product, then weighs the packaging material only. The packaging material weight is subtracted from packaged product weight to obtain the net material weight.

5.2.1.2 Apparatus

5.2.1.2.1 Depth gauge, to be used for dimension testing meeting the following requirements and of the type shown in Figure 2.

Dimensions in millimetres



Key

A taper to a sharp point

B thumb grip

Figure 2 — Depth gauge for thickness measurements

5.2.1.2.2 Disk, fabricated of a suitable plastic material. The disk shall have a mass of (9,3 ± 0,3) g and shall exert a pressure of 20 Pa. The disk shall be 76 mm ± 2 mm in diameter. The disk shall be perpendicular to the pin at all times and shall have a friction device or thumb grip to secure the pin unless purposely moved.

5.2.1.2.3 Pin, made at a maximum of 3 mm in diameter and of sufficient length for the material to be measured.

5.2.1.2.4 Steel rule, graduated in 1 mm intervals.

5.2.1.3 Procedure

5.2.1.3.1 General

The test specimens shall be cut by methods that do not change the structure relative to that of the original product and the test procedure shall be as follows:

5.2.1.3.2 Expansion of packages and cut roll

a) Hold the first batt vertically off the floor by grasping it with both hands on its long dimension so that the lower edge is (460 ± 25) mm above a solid horizontal surface. Release the batt, allowing it to strike the surface.

b) Repeat the actions of a) for a second time. Next, hold the batt by the other long edge, drop twice as a). Place the specimen on the flat, hard surface.

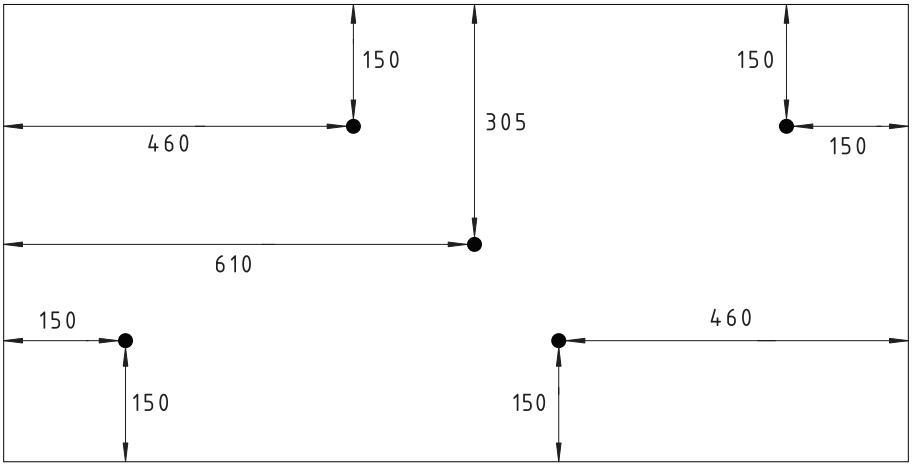
c) Repeat the actions of a) and b) for the remaining four specimens.

d) Allow specimens to reach equilibrium by waiting at least 5 min before making thickness measurements within 25 mm in any direction of five points as indicated in Figure 3.

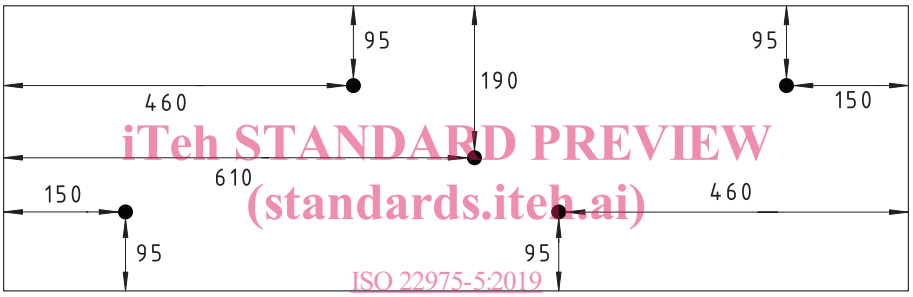
If 580 mm-wide samples are tested, use a quarter or half of that dimension to establish the test points.

NOTE 1 Some materials can require 4 h or more to reach equilibrium.

Dimensions in millimetres



A



B

Key

A 600 mm by 1 200 mm specimen

B 375 mm by 1 200 mm specimen

Figure 3 — Thickness measurement locations

5.2.1.3.3 Expansion of full roll

a) Unroll the insulation. Flip the test roll over its entire length so the bottom surface is now on top. Next grasp one end and pull the material over itself until the original surface is again facing up.

b) If there is insufficient room to pull the material over itself (less than twice the unrolled length), the material may be repositioned by sliding the partially pulled roll to the end of the testing space and continue to pull the material over itself.

c) Use 5.2.1.3.1 if the sampling of cut rolls procedure in 3) of 5.2.1.1 is used.

5.2.1.3.4 Measurement of packages and cut roll

a) Insert the pin of the thickness gauge vertically into the material at the first measuring point with a twisting motion until it contacts the hard surface beneath. Lower the disk until it lightly and uniformly contacts the specimen.

b) An alternative procedure is to use a disk whose mass exerts a specified pressure of at least 20 Pa on the specimen. With the gauge disk locked against the pin, lift the gauge unit from the test specimen.

c) While holding the gauge in locked position, place the disk against the zero end of the rule with the pin projecting along the calibrated surface of the rule.

d) Observe and record the reading at the pointed end of the pin to the nearest 1 mm.

e) Repeat the actions of a), b), c), d) for each of the remaining measuring points as shown in Figure 3.

5.2.1.3.5 Measurement of full roll

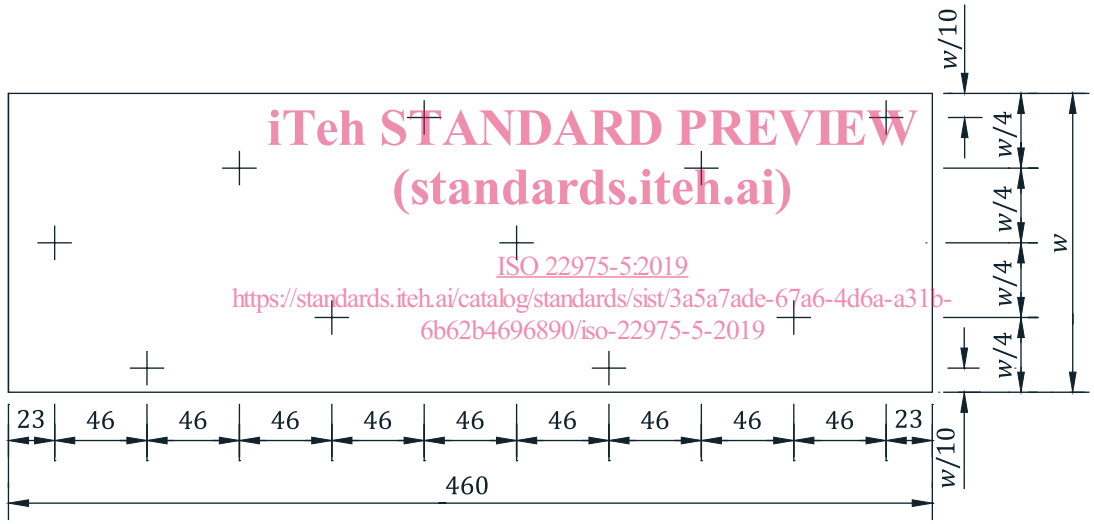
a) Record the roll length to the nearest 2,54 cm. Take measurements on each side of the roll. If the roll has been cut in half, take a third roll length measurement along the midpoint of the roll width.

b) Record roll width at three locations to the nearest 0,32 cm. Width measurements will be taken 3,05 m from each end, and in the middle of the roll length.

c) Using a pin gauge, record thickness to the nearest 1 mm as shown in Figure 4. Refer to 5.2.1.3.4 for use of pin gauge. Two 4,57 m long sections shall be measured. These sections shall be 3,05 m from each end. A total of twenty thickness measurements shall be taken for each roll.

d) Use 5.2.1.3.5 if the sampling procedure in 4) of 5.2.1.1 is used.

Dimensions in centimetres



Key

w roll width

Figure 4 — Thickness measurement locations — Full roll

5.2.1.4 Thickness calculation

Take the average of the thickness measurements made in accordance with 5.2.1.3 as the thickness of the specimen.

5.2.2 Bulk density

5.2.2.1 Sampling

Same as 5.2.1.1.

5.2.2.2 Apparatus

Balance to be used for bulk density testing meeting the following requirements:

a) Scales of sufficient capacity to weigh the test specimen to an accuracy of ±0,5 %.

b) Sensitivity to weigh the test specimen to an accuracy of ±0,5 %

5.2.2.3 Procedure

The procedure for bulk density of the specimen shall be as follows:

a) Weigh the weight of the specimen with facings and the weight of the specimen without facings.

b) Calculate the density of the specimen with facings and the density of the specimen without facings by using Formula (1) and Formula (2):

$$D_a = \frac{M_1}{L_1\, w_1\, H_1} \tag{1}$$

where

D_a is the density of the specimen with facings in kilograms per cubic metre (kg/m^3);

M_1 is the total weight of test specimen with facings in kilograms (kg);

L_1 is the length of test specimen with facings in metres (m);

w_1 is the width of test specimen with facings in metres (m);

H_1 is the thickness of test specimen with facings in metres (m).

$$D_b = \frac{M_2}{L_2\, w_2\, H_2} \tag{2}$$

where

D_b is the density of the specimen without facings in kilograms per cubic metre (kg/m^3);

M_2 is the total weight of test specimen without facings in kilograms (kg);

L_2 is the length of test specimen without in metres (m);

w_2 is the width of test specimen without in metres (m);

H_2 is the thickness of test specimen without in metres (m).

5.2.3 Compression behaviour

It shall be in accordance with ISO 29469.