BS EN 15976:2011

BSI Standards Publication

Flexible sheets for waterproofing — Determination of emissivity

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National foreword

This British Standard is the UK implementation of EN 15976:2011.

The UK participation in its preparation was entrusted to Technical Committee B/546, Flexible sheets for waterproofing and water vapour control.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Abdichtungsbahnen - Bestimmung des Emissionsgrades

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Foreword

This document (EN 15976:2011) has been prepared by Technical Committee CEN/TC 254 “Flexible sheets for waterproofing”, the secretariat of which is held by BSI.

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of an identical text or by endorsement, at the latest by October 2011, and conflicting national standards shall be withdrawn at the latest by October 2011.

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1 Scope

This European Standard specifies the method to determine the emissivity of plastic, rubber and bitumen vapour control layers, underlays for walls and underlays for discontinuous roofing.

It also defines a conditioning procedure for these product families in order to quantify the sensitivity of emissivity to humidity and temperature.

2 Normative references

The following referenced documents are indispensable for the application of this European Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 13416, *Flexible sheets for waterproofing — Bitumen, plastic and rubber sheets for roof waterproofing — Rules for sampling*

3 Terms and definitions

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

3.1
emissivity
emissivity of a material (usually written ε) is the ratio (proportion) of the energy radiated by a surface relative to the energy radiated by a blackbody at the same temperature. It is a measure of a material's ability to radiate heat

3.2
blackbody
blackbody is a theoretical object that absorbs all electromagnetic radiation that falls on it at all wavelengths. No electromagnetic radiation passes through it and none is reflected

NOTE A blackbody is also a perfect emitter with a normal and corrected emissivity of 1.

3.3
TIR
Thermal Infrared Radiation principle

4 Symbols

For the purposes of this document, the following symbols apply

c specific heat capacity is the measure of the heat energy required to increase the temperature of a unit quantity of a substance by a certain temperature interval.

λ the wavelength λ is the distance between repeating units of a propagation wave of a given frequency.

NOTE In this document it is understood the wave length is limited to the infrared light spectrum.

α (alpha) represents the absorption coefficient of a surface and is the ratio of the radiant energy absorbed by that surface relative to that of a blackbody at the same temperature.

ε (epsilon) emissivity (see above definition of emissivity) ($0 \leq \varepsilon \leq 1$).

ρ (rho) reflectivity coefficient is the proportion of the incident electromagnetic radiation reflected from a surface or an optical element.

τ (tau) transmission coefficient is the proportion of incident electromagnetic radiation (light) passes through a surface or an optical element.

ε_L emissivity for the low emissive calibration standard.

ε_H emissivity for the high emissive calibration standard.

U sensor signal of the specimen in Volt.

U_H sensor signal of the high emissive calibration standard in Volt.

U_L sensor signal of the low emissive calibration standard in Volt.

5 Principle of low emitting surfaces

Flexible sheets for waterproofing with a low emitting surface are commonly referred to as radiant or reflective barriers. The principle of a radiant barrier is based on its ability to reflect radiant heat instead of absorbing it. Radiation (radiant heat) is the transmission of electromagnetic rays through space and in this context "radiation" refers only to the energy of infrared rays. At any temperature, all objects radiate infrared rays, which travel in all directions until they are reflected or absorbed by another object. The heating of objects excites the molecular surface structure, resulting in an emission of infrared radiation from the surface.

The radiative flux through a body will satisfy the conservation-of-energy equation:

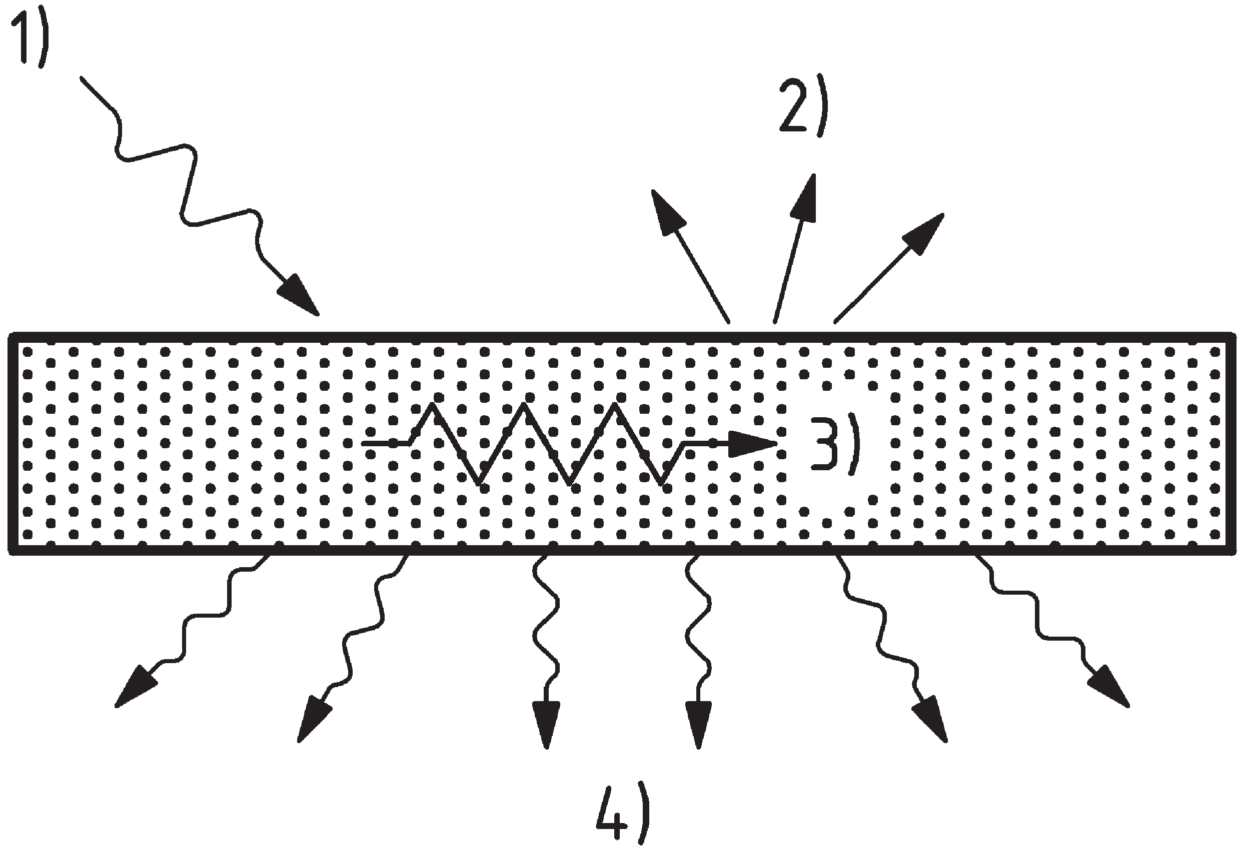
$$\alpha + \rho + \tau = 1$$

Radiant barriers are typically rather opaque to infrared radiation, so in a simplified consideration the transmission is negligible:

$$\Leftrightarrow \tau = 0$$

$$\Leftrightarrow \alpha + \rho = 1$$

$$\Leftrightarrow \alpha = 1 - \rho$$



Key

1	Incident energy	3	Absorbed energy
2	Reflected energy	4	Emitted energy

Figure 1 – Energy diagram

The amount of emitted radiation is a function of the emissivity factor (ε) of the source surface. At the same nominal wave length the absorption factor (α) equals the emissivity factor (ε):

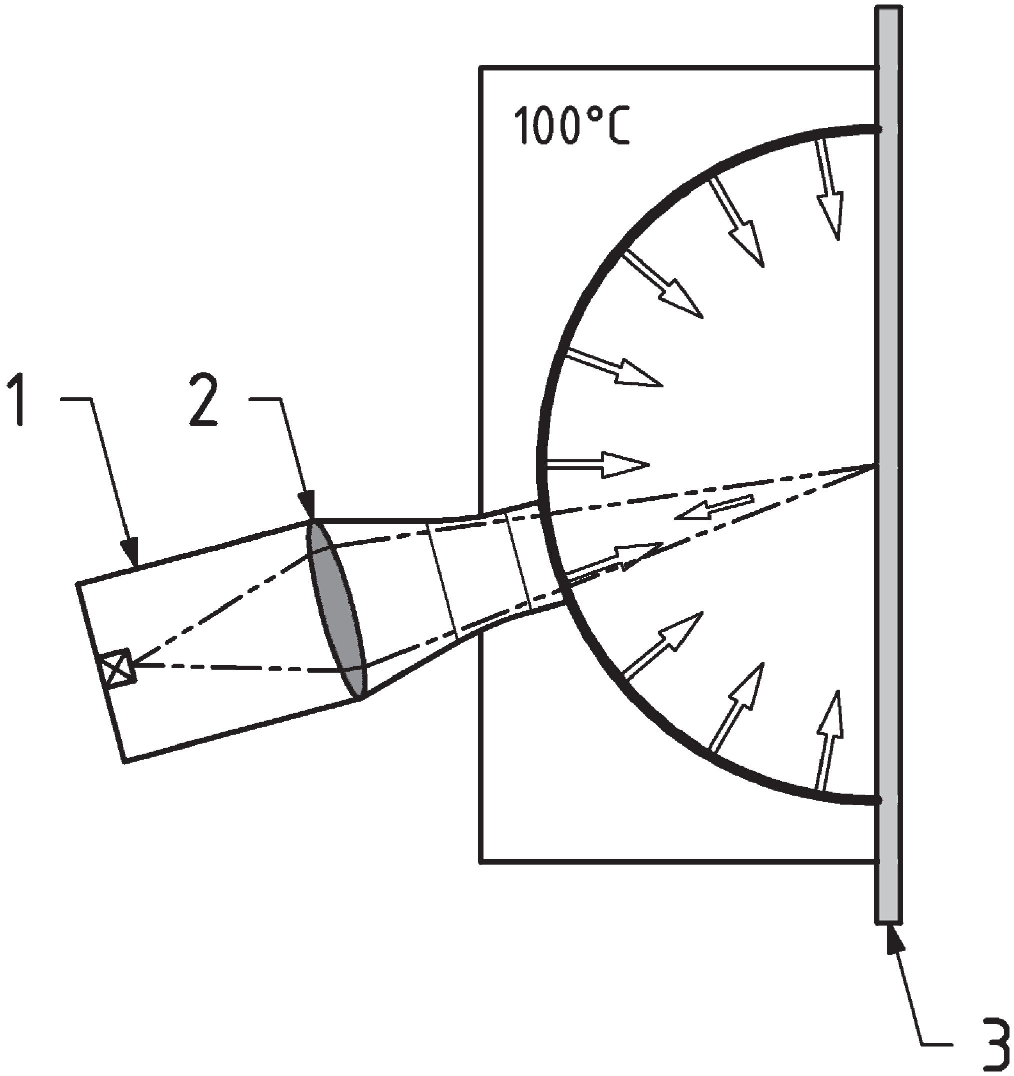
$$\alpha = \varepsilon$$

6 Hemispherical blackbody radiator

6.1 Principle of hemispherical blackbody radiator

The hemispherical radiator (half sphere) in the form of a blackbody uses the thermal infrared radiation principle (TIR-principle). The temperature of the blackbody is set and controlled at 100° (+/- 0,5 °C). The hemispherical shape of the radiator is necessary in order to achieve a complete and homogenous illumination of the measuring surface allowing even the emissivity of rough and structured surfaces to be measured correctly. Part of the energy reflected and emitted by the sample passes through a small opening in the hemispherical radiator and is focussed onto an infrared sensor by an infrared lens. The infrared sensor changes the incident thermal radiation into a voltage signal in a broad band and linear manner (the voltage signal is proportional to the reflected thermal energy).

At any given temperature of a blackbody, the spectral distribution of the thermal radiation is given by Planck's law. The radiator's temperature has been chosen to be 100° (± 0,5 °C) so that the corresponding spectrum has its peak at a wavelength (λ) of ca 8 μm and more than 97 % of the radiant energy is in the wavelength range from (2,5 to 40) μm.



Key

1 Thermopile Ir Sensor
2 Ir lens
3 Sample

Figure 2 – Hemispherical blackbody radiator

6.2 Description of hemispherical blackbody radiator and of the specimen holder

In order to reduce the hemispherical blackbody radiator (in the following also written as apparatus) related errors to a minimum the half sphere should have a diameter of not smaller than 70 mm. Also the distance of the surface to measure to the apparatus shall be approximately 2 mm. The axis of the infrared sensor and infrared lens assembly shall point at the centre of the specimen and shall be between 70° and 80° to the specimen surface.

An adequate electronic method to evaluate the measuring signals should be applied. In order to avoid the heat up of the specimen the measuring time should be limited to 3 s maximum.

The specimen holder should have a solid flat front surface with a minimum of 140 mm by 140 mm. The fixation of the specimen onto the specimen holder should be adapted to the type of material to test. The specimen must be flat and wrinkle-free over the whole surface. Thin materials may be wrapped around the left and the right edges of the specimen holder and then fixed on both sides by magnetic strips. For thick and stiff materials, fixing should be adapted on case by case basis (clamps, hooks, etc.). The specimen must be maintained parallel to the apparatus during measurement. The distance of 2 mm between specimen and apparatus should be pre-defined by spacers, which should also prevent any rocking of the specimen.

Dimensions in millimetres

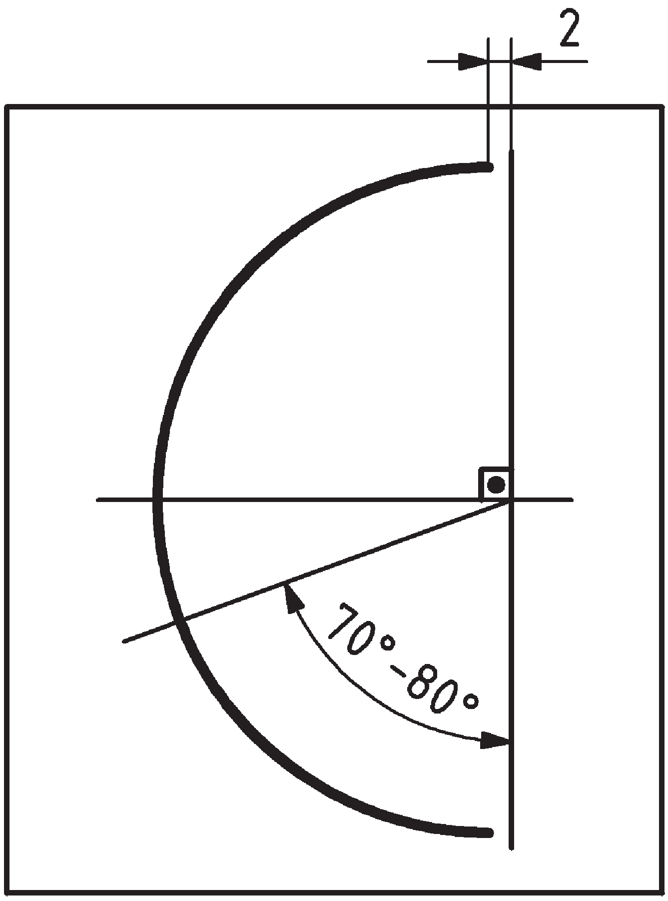


Figure 3 – Hemispherical blackbody radiator and specimen

6.3 Handling procedure of calibration standards

Typical calibration standards for low emitting surface should be 0,01 < ε_L < 0,02. For high emitting surface, the calibration standard should have ε_H > 0,94.

Calibration standards must be certified by the manufacturer of the apparatus or by an independent Institute, accompanied by a certificate showing the measured emissivity. The calibration standards must be recertified (or replaced by new certified standards) at least every two years.

The calibration standards must be stored in a dark, clean, dust-free and dry environment. If the low emissivity calibration standard shows up spots with different brightness, scratches or other visual defects caused by handling, it shall be replaced.

6.4 Calculation of the emissivity

Determination of the emissivity (ε) results from comparing the measuring result of the specimen with the two calibration standards. With the sensor signals (U, U_H and U_L) and the known emissivity of calibration standards (ε_L and ε_H), the ε of the specimen is calculated by:

$$\varepsilon = \varepsilon_H - (\varepsilon_H - \varepsilon_L) \frac{(U_H - U)}{(U_H - U_L)}$$

6.5 Measurement range of hemispherical blackbody radiator

The measurement range of the apparatus is limited to values between those of the two calibration standards used thus from emissivity range of 0,02 – 0,94.

7 Sampling and preparation of the test specimens

7.1 Sampling

A sheet sample of an undamaged roll shall be selected in accordance with EN 13416.

7.2 Dimensions and numbers of specimens

A minimum of five specimens should be taken with a regular spacing. The specimen size should be adapted to the size of the specimen holder and to the fixation system of the specimen holder (see 6.2).

7.3 Preparation of specimens before testing

The specimens should be kept for a minimum of 2 h at a temperature of 23 ± 2 °C and relative humidity of 50 ± 20 %. Special precaution should be taken to ensure that the calibration standards, the specimens and the apparatus are equilibrated in the same standard climatic conditions. Air currents and draughts in the measuring area must be avoided.

8 Procedure for measurement of specimens

The apparatus should be switched on at least 2 h before calibration and beginning measurements. The apparatus should be installed in a fixed position and must not be moved during measurement. The specimen is brought up to the apparatus in a vertical orientation, pressed firmly against the spacers around the measuring window of the apparatus and the apparatus is activated to begin measurement. In order to avoid that the specimen temperature changes during the measurement, the residence time of the specimen in the measuring position must be reduced to a minimum. Between specimen positioning and start of measurement, not more than 1 s shall pass.

If this speed of measurement is not achieved, if the measurement is otherwise interrupted or if the measurement on a specimen is to be repeated, the specimen should be withdrawn from the apparatus for the time it needs to cool down to laboratory temperature. The higher the emissivity and/or the lower the specific heat capacity (c) of the material, the longer the specimen will need to cool down to laboratory temperature.

In order to reduce measurement variability to a minimum (laboratory, specimen and apparatus related), after a time interval of maximum 1 h, the apparatus shall be recalibrated using the two calibration standards.

9 Expression of the results

The emissivity of the specimen is directly indicated as a three decimal number. The emissivity mean value, all the single values per specimen and the standard deviation of the results from the tested product shall be included on the test report. The emissivity mean-value is to be rounded to two digits.

All single measurements resulting in an emissivity < 0,02 or > 0,94 (measurement range of the apparatus) should be set to 0,02 or 0,94 respectively.

10 Emissivity after conditioning

10.1 Specialities of application related aging

The standard aging procedures (described in EN 13859-1, EN 13859-2, EN 13984 and EN 13970) are not pertinent regarding emissivity. The key aggression element which may have an impact on emissivity is humidity. Humidity is not considered in the EN 13859-1, EN 13859-2, EN 13984 and EN 13970 standards.

Long term functionality of a low emissivity surfaces in the application is primarily linked to the ability of the material to resist oxidation (corrosion).

10.2 Conditioning procedure

One set of specimens (see Clause 7) is to be exposed in a climatic chamber to 90 % relative humidity and 70 °C temperature for 28 days. For expression of the results of emissivity after conditioning, see Clause 9.

Bibliography

[1] EN 13859-1, *Flexible sheets for waterproofing — Definitions and characteristics of underlays — Part 1: Underlays for discontinuous roofing*

[2] EN 13859-2, *Flexible sheets for waterproofing — Definitions and characteristics of underlays — Part 2: Underlays for walls*

[3] EN 13984, *Flexible sheets for waterproofing — Plastic and rubber vapour control layers — Definitions and characteristics*

[4] EN 13970, *Flexible sheets for waterproofing — Bitumen water vapour control layers — Definitions and characteristics*

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