BS EN 927-4:2000

Paints and varnishes — Coating materials and coating systems for exterior wood —

Part 4: Assessment of the water-vapour permeability

The European Standard EN 927-4:2000 has the status of a British Standard

ICS 87.040

National foreword

This British Standard is the official English language version of EN 927-4:2000.

The UK participation in its preparation was entrusted by Technical Committee STI/28, Paint systems for non-metallic substrates, to Subcommittee STI/28/2, Coating systems for wood, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 9 and a back cover.

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Peintures et vernis - Produits de peinture et systèmes de peinture pour bois en extérieur - Partie 4: Détermination de la perméabilité à la vapeur d'eau

Lacke und Anstrichstoffe - Beschichtungsstoffe und Beschichtyngssysteme für Holz im Außenbereich - Teil 4: Beurteilung der Wasserdampfdurchlässigkeit

This European Standard was approved by CEN on 7 July 2000.

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Contents

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 139 "Paints and varnishes", the secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by January 2001, and conflicting national standards shall be withdrawn at the latest by January 2001.

EN 927 consists of the following parts under the general title *"Paints and varnishes – Coating systems for exterior wood":*

Part 1: Classification and selection
Part 2: Performance specification
Part 3: Natural weathering test
Part 4: Assessment of the water-vapour permeability
Part 5: Assessment of liquid water permeability

Annex A is for information only.

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.

Introduction

The treatment of exterior wood surfaces has both aesthetic and protective functions. A vital purpose of a coating system is to protect the wood against aesthetic deterioration (e.g. blue stain attack) and dimensional changes. Because such attacks are mainly caused by high moisture contents in the wood, a knowledge of the relative water vapour permeability properties of coating materials applied to exterior wood is helpful in selecting products for particular end-use applications, as described in EN 927-1.

This part of EN 927 provides a method for determining the water-vapour permeability of coating materials applied to exterior wood.

1 Scope

This part of EN 927 specifies a test method for assessing the water-vapour permeability of coating systems for exterior wood by measuring the absorption and desorption of water vapour by coated wood panels.

Results are expressed as the mass, in grams, of water gained and lost during two 14 day periods under specified conditions.

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 927-1	1996	Paints and varnishes – Coating materials and coating systems for exterior wood – Part 1: Classification and selection
EN ISO 2808	1999	Paints and varnishes – Determination of film thickness (ISO 2808:1997)
ISO 554	1976	Standard atmospheres for conditioning and/or testing – Specifications

3 Terms and definitions

For the purposes of this part of EN 927, the following terms and definitions apply:

3.1 water absorption

The ability of a coated surface area to absorb water from liquid or vapour [EN 927-1 : 1996]

3.2 water permeability

The ability of a coating system to allow the transmission of water as liquid or vapour. [EN 927-1 : 1996]

4 Test panels

4.1 Wood

The wood shall be spruce (*Picea abies*) that has been selected to be free from knots and cracks, to be straight-grained and of normal growth rate (i.e. between 3 and 8 annual rings per 10 mm). The inclination of the growth rings to the test face shall be (45 ± 10)°.

The wood shall be free from blue stain and evidence of surface or bulk infection. Abnormal porosity (caused by bacterial attack) shall be avoided.

> NOTE: Abnormally porous wood may be detected qualitatively by the rapid absorption of a drop of propan-2-ol(isopropanol) applied to a small surface; the drop should not be absorbed in less than 30 s by normal wood. The test should be carried out at not less than six places, widely separated on the test panel.

The density of the wood shall be between 0,4 g/cm^3 and 0,5 g/cm^3 when measured at an equilibrium moisture content of approximately 12 %. The measured density shall be recorded.

Condition the wood prior to conversion into test panels in accordance with ISO 554:1976 at (20 ± 2) °C and a relative humidity of (65 ± 5) % to an equilibrium moisture content of (13 ± 2) %.

4.2 Preparation and selection of test panels

Convert the conditioned wood into the panels that will serve as the coated and uncoated panels in the test. The panels to be tested uncoated shall be nominally (150 ± 2) mm × (70 ± 2) mm × (20 ± 2) mm. Panels for coating shall be (340 ± 2) mm × (70 ± 2) mm × (20 ± 2) mm. It is intended that after coating one panel 150 mm in length will be cut from each end of this 340 mm long panel. This will leave an off-cut C_c approximately 40 mm in length from the middle of the panel, to be used in due course for the determination of film thickness (see 4.3.5 and figure 1).

The panels shall be planed all round to a smooth and uniform finish and shall not be sanded. Any panels showing surface splitting shall be rejected.

4.3 Preparation of coated and uncoated panels

4.3.1 Wood conditioning

Prior to coating, condition the panels to constant mass in accordance with ISO 554:1976 at (20 ± 2) °C and a relative humidity of (65 ± 5) %. Panels shall be weighed at intervals of not less than one day. The mean value of the five most recent readings shall be calculated. If none of these five readings differs from the mean value by more than 1,5 %, then the panel shall be considered to have reached a stable mass.

Keep the panels under the same climatic conditions during drying of the coating system and subsequent storage of test panels prior to testing.

4.3.2 Panel selection

Select three 340 mm long panels for each of the coatings to be tested. Select also five 150 mm long panels for testing in the uncoated condition; this set of panels can serve as uncoated controls for one or more test coatings.

Mark each of the uncoated panels and those to be coated to identify the test face as that convex to the annual rings.

Dimensions in millimetres

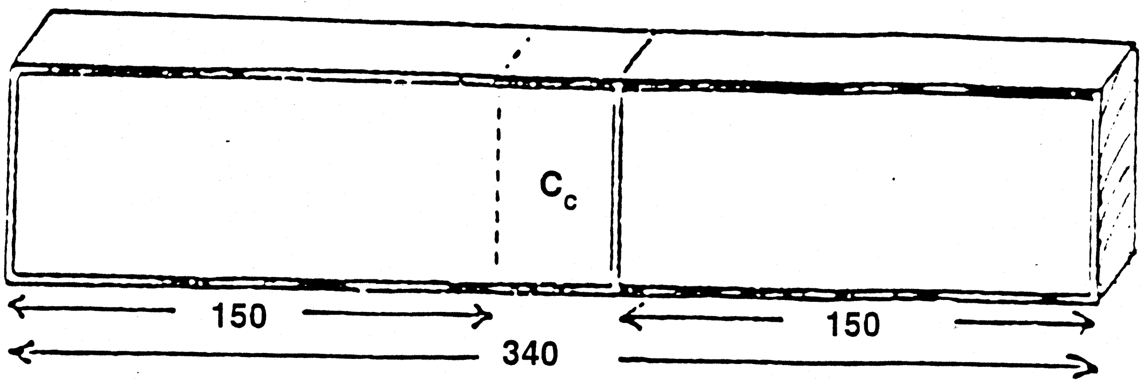

Figure 1: Cutting of the test panels

4.3.3 Coating application

Apply each coating system to the test face only of the panels to be coated. Use the method specified by the manufacturer and achieve a wet film thickness corresponding to the mean value of the manufacturer's recommended spreading rate. An individual variation on and between panels of 20 % of the mean value is permitted. No correction for variations in coating thickness shall be made. (When application is carried out by brush weigh the brush and paint container before and after each application and calculate an average value in grams per square centimetre for coating application to the three long panels.)

When the coating systems have dried, cut a test panel 150 mm in length from both ends of each long panel (figure 1). Examine the six coated test panels that are produced and select the best five for water absorption testing.

The three small coated off-cuts C_c are used for the determination of film thickness as decribed below.

4.3.4 Sealing and ageing

Seal the sides, end-grains and reverse faces of the five coated and five uncoated panels against water entry using at least two coats of a flexible coating, as moisture-impermeable as possible, for example a solvent-free epoxy or polyurethane paint. The sealer shall cover the edges completely and overlap the test face by 2 mm.

After sealing, age the panels for approximately 28 days in the controlled environment (see 4.3.1) until constant mass is achieved.

4.3.5 Dry film thickness

Determine the dry film thickness of the coating on the off-cuts C_c of the test panels. Remove one small chip of coated wood from each of the off-cuts and examine by microscopy in accordance with EN ISO 2808:1999, method 5A. Make 5 measurements on each chip and calculate and record the mean value in micrometres.

The dry film thickness is defined as the thickness of the layer on (or above) the wood surface. Systems may penetrate the wood material to some extent, but this part is not included in the determination.

5 Apparatus

5.1 Microscope, for measurement of dry film thickness in accordance with EN ISO 2808:1999, method 5A.

5.2 Conditioning room, of appropriate size, controlled at a temperature of (20 ± 2) °C and a relative humidity of (65 ± 5) %, in accordance with ISO 554:1976.

5.3 Climate chamber

Use a vessel of suitable size and shape and provided with a removable, close-fitting lid. The vessel shall be equipped with horizontal open racks to support the panels such that the backs of the panels will be at least 40 mm above the bottom of the chamber.

Line the walls of the chamber for their full height with filter paper and introduce sufficient deionized water to cover the bottom of the chamber to a depth of 10 mm. Close the lid.

Place the chamber in the controlled room specified in 5.2. The conditions in the chamber should stabilize at about 98 % relative humidity within 24 h.

5.4 Balance, capable of weighing 500 g to the nearest 0,01 g.

6 Procedure

6.1 Pre-conditioning

It is known that the water permeability of some types of coating can change markedly during a relatively short period of exposure to water. For such coatings the values of water permeability obtained during a short period of contact with water may not be representative of those obtained during long-term service. For this reason all coatings are required to be subjected to a leaching procedure before commencement of the absorption cycle.

This procedure shall be carried out twice as follows:

– 24 h floating face down in deionized water, such that the test face is fully submerged;

– 3 h drying at (20 ± 2) °C and a relative humidity of (65 ± 5) % in accordance with ISO 554:1976;

– 3 h drying at 50 °C;

– 18 h drying at (20 ± 2) °C and a relative humidity of (65 ± 5) % in accordance with ISO 554:1976.

The uncoated (U) and coated (C) panels shall always be handled together.

After preconditioning, the test panels shall be acclimatized by returning them to the controlled environment (see 5.2) until a stable mass is achieved once more.

6.2 Absorption cycle

Label the five coated and uncoated panels A to E. Weigh each of the coated and uncoated panels to the nearest 0,01 g and record their initial mass $m(0)$ for each panel.

Introduce the panels into the climate chamber situated in the controlled environment. Lay the panels on the racks with the test coating facing upwards, ensuring that the spacing between the panels is a minimum of 10 mm to ensure good circulation of water vapour. Ensure also that the distance between the backs of the panels and the water level is the required minimum of 30 mm. Loading and unloading of the chamber shall be carried out as quickly as possible to minimize any disturbance to the internal climate. Note the time of commencement of exposure.

After 14 days remove the test panels from the chamber, blot lightly to remove any water droplets and weigh. The time interval from the removal of the test panels to weighing should be as short as possible and always the same, as water evaporates relatively quick from the test panels. Record for each panel the period in the chamber and its mass $m(14)$.

All handling of the panels shall be carried out in the controlled environment specified in 4.3.1.

6.3 Desorption cycle

After the panels have been weighed at the end of the water absorption stage, place them in the controlled environment (see 4.3.1), ensuring good air circulation rates (0,25 m/s to 0,5 m/s) in the vicinity of the panels. After 14 days reweigh each panel and record its mass $m(28)$ and the elapsed time in hours.

6.4 Optional testing of weathered panels

If required, coatings may be subjected to a weathering test before or after measurement of water-vapour permeability.

7 Calculation and expression of results

At the conclusion of the total 28 day test period the results are to be expressed to the nearest 0,01 g for each coated system tested, and the uncoated control, as follows:

Initial masses	$m_A(0)$, $m_B(0)$, $m_C(0)$, $m_D(0)$, $m_E(0)$;
14 day mass gain	$m_A(14)$, $m_B(14)$, $m_C(14)$, $m_D(14)$, $m_E(14)$;
14 day mass loss	$m_A(28)$, $m_B(28)$, $m_C(28)$, $m_D(28)$, $m_E(28)$.

Calculate for each of the five test panels A to E the mass increase after 14 days water absorption, $m_A(14) - m_A(0)$ etc., and the mass loss after 14 days water desorption, $m_A(14) - m_A(28)$ etc.

Calculate from the mass increases of the five panels after 14 days the arithmetic mean for water absorption, in grams, WA (14), and its standard deviation.

Calculate from the five values for mass loss at the end of the test the arithmetic mean for water desorption in grams, after 14 days, WD (14), and its standard deviation.

8 Test report

The test report shall contain at least the following information:

a) all details necessary to identify the products tested;

b) a reference to this part of EN 927 (EN 927-4);

c) the arithmetic mean WA(14) and the standard deviation for water absorption for each system tested;

d) the arithmetic mean WD(14) and the standard deviation for water desorption for each system tested;

e) the arithmetic mean WA(14) and the standard deviation for water absorption for the uncoated control panel;

f) the arithmetic mean WD(14) and the standard deviation for water desorption for the uncoated control panel;

g) the density of the wood used for the test panels;

h) the spreading rate;

i) the mean value of the dry film thickness of the test coating;

j) any deviation from the test method specified;

k) the date the test was initiated (day 1 of the 28 day test period).

Annex A (informative)

Interpretation of test results and further calculations

Introduction

As indicated in the scope of this standard, the purpose of this test is to provide some indication of the moisture build up within a wooden component and hence the propensity to decay and mould growth. Unfortunately it is not meaningful to make such a prediction on the basis of a single measurement. Moisture content will depend on the permeabilities of the coating to water and water vapour, but also on other factors such as the climatic conditions and detailed design features of the component. A number of research organisations are investigating this problem, and it may be possible in the future to make predictions about moisture fluctuations in building components from parameters measured in the laboratory. In the meantime judgements are made by comparing the relative performance of coating systems. In this way some insight into the likely behaviour of new systems can be made by comparison with established products. This standard provides a common measure for comparison which may be aided by the derivation of further units. Some possibilities with a brief comment on constraints are indicated below.

A.1 Water vapour transmission rate per unit area of coating

This figure may be derived by dividing WA (14) or WD (14) by the area, in square metres, of the coated test face to give the 14 day absorption or desorption transmission rates in kilograms per square metre. Although such coefficients may be used to give an indication of the mass of water that would enter or leave components of different surface area, it should be noted that the figure may change according to the actual dimensions.

A.2 Water vapour transmission rate per unit film thickness of coating

The permeability of coats is often expressed in units which are normalized with respect to film thickness. Using the film thickness data recorded to check spreading rate it would be possible to derive such a unit expressed for example per micrometer of solid coat. However, there are a number of drawbacks for surface coatings. In the case of zero build stains the concept of film thickness is ambiguous. For coating systems a transmission rate may be controlled by the least permeable part of the system, and for coatings which undergo curing the transmission rate is a non-linear function of film thickness. It is therefore recommended that rates are also expressed for the system under test and not normalized for film thickness only.

A.3 Water vapour uptake (or desorption) coefficient

A water vapour uptake coefficient can be defined on the assumption that water vapour uptake obeys Fick's law of diffusion in which case uptake will be a linear function of the square root of time. Thus the water vapour uptake coefficient would be defined as WA $\cdot$ $T^{0,5}$, where T is the time, in hours. For this test method T = 14 days = 336 h; hence $T^{0,5}$ = 18,33.

Water vapour uptake is often expressed in kilograms per square metre (e.g. DIN 52617, *Bestimmung des Wasseraufnahmekoeffizienten von Baustoffen*). If a comparison is to be made, WA (14) should be divided by the area of the coated wood surface and the mass expressed in kilograms.

The advantage of the water vapour uptake coefficient is that it is normalized for time and can be used to calculate water vapour uptake for other periods of time or compared to measurements taken over different time periods. However, there is experimental evidence to show that Fick's law may not be obeyed in all circumstances and water vapour uptake may not be a linear function of $T^{0,5}$.

A.4 Moisture-excluding effectiveness and relative moisture permeability

By taking the uncoated panel as a reference control it is possible to express the water vapour uptake of the test system as a relative exclusion factor. "Moisture-Excluding Effectiveness" (MEE) is calculated so that 100 % represents complete exclusion and 0 % represents no moisture protection, i.e.:

$$MEE = \frac{\text{WA (14) uncoated} - \text{WA (14) coated)}}{\text{WA (14) uncoated}} \times 100.$$

Clearly this figure will decrease as the test period increases and a period of time shall be specified for comparison, in this case 14 days.

For parameters such as MEE the value will be dependent on the amount of water absorbed by uncoated wood, and this in turn will be affected by density of the wood. Thus, the higher the density of the wood, the higher will be the nominal MEE of the finish applied to it.

A relative moisture permeability is sometimes calculated by dividing the mass gain of the test system by the mass gain of the uncoated control and multiplying by 100. In this case, 0 % represents complete exclusion and 100 % no protection.

A.5 Dynamic moisture permeability (DMP)

This term has been used to describe the ratio of water vapour uptake to water lost as a percentage. Thus

$$DMP = 100 \times WA(14) / WD(14).$$

It could be interpreted as the percentage of absorbed water that is released after the 14 day drying period. This expression is of interest as it is found that some coatings release a higher percentage than others. However, as this is a ratio it does not reflect the total moisture movement. Two coating systems could have very different permeabilities but still show a similar DMP.

A.6 Time moisture content (TMC)

The term TMC has been used to denote the number of days a coated wooden panel or assembly is above 20 % moisture content and therefore vulnerable to decay. One method is to record the area under a specified absorption/desorption curve, for which the test piece remains above 20 %. A more simplified procedure is to only record the number of days above 20 %. An estimate of the number of days for this present test method can be made using the water vapour uptake coefficient and the known density of the test piece. However, it should be noted that this period could be very different for other test periods and humidity cycles.

NOTE: The EN 927-4 test method has been constrained to 28 days to provide a simple method for eventual inclusion in the performance specification prENV 927-2:2000. In principle the same test procedure might be used for other periods of test.

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