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BSI Standards Publication

Paints and varnishes — Coating materials and coating systems for exterior wood — Assessment of tannin staining

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee STI/28, Paint systems for non-metallic substrates.

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

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Beschichtungsstoffe - Beschichtungsstoffe und Beschichtungssysteme für Holz im Außenbereich - Beurteilung von unerwünschten Verfärbungen aufgrund von Holzinhaltsstoffen

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Foreword

This document (CEN/TS 16498:2013) has been prepared by Technical Committee CEN/TC 139 “Paints and varnishes”, the secretariat of which is held by DIN.

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Introduction

Coatings on exterior wood surfaces have both decorative and protective functions. A valued function of the coating system is to protect against discoloration caused by the presence of wood extractives in the coating migrating from the wood material. Bleeding of extractives can occur at different stages, including shortly after coating application and at a later stages in use, when driving forces like fluctuating humidity are present.

1 Scope

This Technical Specification specifies a test method for assessing the discoloration of coatings on wood by tannin staining due to wood extractives. The method uses an extract from Merbau wood as an indicator. Bleeding of wood extractives is assessed at two specified stages firstly after coating application and secondly after cyclic climate exposure. A qualification of colour differences that can be attributed to three different causes, bleeding of extractives, low opacity of the coating film or general yellowing in climate exposure, is included. This document does not specify acceptance values for colour differences that can be tolerated and it is not applicable to staining caused by knots for which there is a different test method (e. g. CEN/TS 16359).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 927-5, *Paints and varnishes - Coating materials and coating systems for exterior wood - Part 5: Assessment of the liquid water permeability*

ISO 554, *Standard atmospheres for conditioning and/or testing — Specifications*

ISO 3131, *Wood — Determination of density for physical and mechanical tests*

ISO 7724-2, *Paints and varnishes — Colorimetry — Part 2: Colour measurement*

3 Terms and definitions

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

3.1
tannin staining
appearance of discoloration on coated surfaces caused by wood extractives in the substrate

3.2
knot staining
appearance of discoloration on coated surfaces caused by wood extractives in knots

3.3
wood extractives
low-molecular weight wood components soluble in organic solvents or water

4 Apparatus and materials

4.1 1 l measuring cylinder.

4.2 Balance, with an accuracy of 0,01 g.

4.3 CIELAB Spectrophotometer, with d/8 geometry, D65 light source and 10° standard observer.

4.4 Chips of Merbau wood (*Intsia sp.*), produced by drilling.

4.5 1 l round bottom flask with a water cooled condenser.

4.6 Round bottom heater.

4.7 Coating applicator, with a 60 µm gap and 40 mm to 100 mm width.

4.8 Equipment for coating application.

4.9 Black/white contrast cards.

4.10 Climate chamber to maintain (20 ± 2) °C and (65 ± 5) % relative humidity.

4.11 Climate chamber to maintain (60 ± 2) °C and (100 ± 5) % relative humidity.

4.12 Climate chamber to maintain (23 ± 2) °C and (50 ± 5) % relative humidity.

5 Procedure

5.1 Preparation of wood extract

For each test a fresh wood extract solution with defined concentration is produced using the following procedure:

— weigh approximately 30 g of Merbau wood (*Intsia sp*.) wood chips in a 1 l round bottom flask equipped with a water cooled condenser (see Figure 1);

— add approximately 500 g deionised water;

— heat this mixture 8 h at 100 °C to boiling and let cool down 16 h. Repeat this cycle 3 times in total;

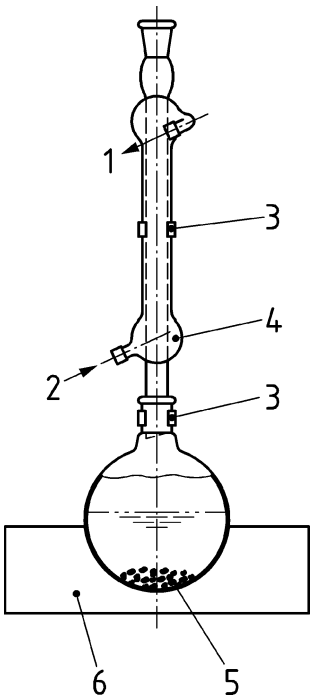
— cool the solution to room-temperature and filter;

— on a sample of the solution measure the solid content in % (by mass) by evaporation;

— concentrate the solution by evaporation and dilution with water to a remaining solution of 3 % solid content.

The solution may be applied for a period of 1 month provided it is kept cool.

The extraction apparatus is shown in Figure 1.



Key

1 water out
2 water in
3 clamp
4 condenser
5 Merbau wood with deionised water
6 heat source

Figure 1 — Extraction model

NOTE Merbau wood is a commercially used wood species that is known to have a very high amount of extractives compared to other wood species.

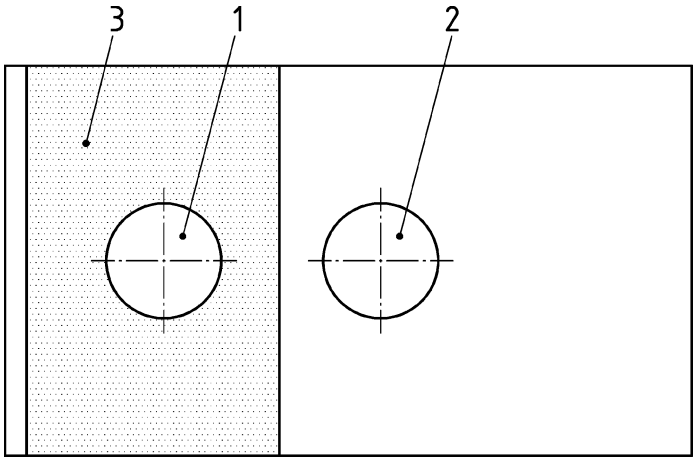
5.2 Wood panels, extract application and sealing

Boards of Beech wood (*Fagus sylvatica*) are selected with normal growth rate (i. e. 2 annual rings to 6 annual rings per 10 mm) and straight grain. From these boards panels with the dimensions 150 mm × 74 mm × 20 mm free from knots and cracks are produced, so that the inclination of the growth rings to the test surface is 60° to 90°. The panels shall be planed to a smooth and uniform finish. In order to avoid an aged wood surface, the panels should be hand sanded (mesh 150) immediately before application of the Merbau wood extract.

The wood shall be conditioned at (20 ± 2) °C and a relative humidity of (65 ± 5) % (in accordance with ISO 554) until equilibrium has been reached, i. e. normally minimum for one month and maximally for 6 months. After conditioning, wood density is determined according to ISO 3131.

Apply a layer of the Merbau wood extract using a coating applicator with a gap size of 60 µm on 6 Beech wood panels across the grain (see Figure 2) and let the solution dry for min. 8 h at (20 ± 2) °C (65 ± 5) % relative humidity. Repeat the application after drying.

Seal all sides except the test face of the panels with a sealer according to EN 927-5.



Key

1 stained surface (S)

2 reference (R)

3 extract

Figure 2 — Drawing of sample with wood extract applied on a part of the test surface (regions for colour measurements)

5.3 Coating application

Apply the coating system to the front side of 6 panels using the method specified by the manufacturer to give a wet film thickness corresponding to the mean value (±20 %) of the manufacturer's recommended spreading rate. Record the quantity of coating applied. The values should be stated preferably in gram per square metre, but may also be expressed as wet film thickness, in micrometres.

Apply the same coating system on a black/white contrast card. For spray applied coating systems fix the contrast card on a wood panel and use the same application method as on the Beech wood panels. Brush applied systems shall by applied on the contrast card using a film applicator.

After coating application, condition the panels and contrast cards for 7 days in the controlled environment at (20 ± 2) °C and a relative humidity of (65 ± 5) % in accordance with ISO 554.

5.4 Colour measurements after coating application

After conditioning the panels for 7 days in the controlled environment, colour is measured on each panel at six spots in the region S (surface over wood extract) and on six spots in the region R (surface without wood extract) according to Figure 2. It is recommended to fix the position of the spots for measurement by using a template.

After conditioning the black/white contrast cards for 7 days in the controlled environment, colour is measured on four spots on the coated white substrate and on four spots on the coated black substrate.

The colour shall be measured in CIELAB colour coordinates with an apparatus with illuminant D65/10° standard observer as specified in ISO 7724-2. Specular gloss may be included or excluded, but the selected principle should be stated.

5.5 Cyclic climate exposure

The coated Beech wood panels are subjected to cyclic climate exposure consisting of 8 cycles of 24 h at (60 ± 2) °C and (100 ± 5) % relative humidity and 24 h at (23 ± 2) °C and (50 ± 5) % relative humidity. Over the weekends panels are stored at (23 ± 2) °C and (50 ± 5) % relative humidity.

5.6 Colour measurements after cyclic climate exposure

After cyclic climate exposure, colour is measured on each panel at six spots in the region S (surface over wood extract) and on 6 spots in the region R (surface without wood extract) according to Figure 2. It is recommended to measure in the same positions as before climate exposure by using a template.

Colour measurements are carried out according to the CIELAB-System with d/8 geometry, D65 light source and 10° standard observer.

5.7 Calculation and assessment of colour differences

From the CIELAB colour data measured before and after cyclic climate exposure colour differences are calculated as ΔE^*, ΔL^* and Δb^*. Table 1 describes the colour differences that shall be calculated by subtracting the standard values from the values in the end condition or on the stained area. Results are stated as mean values and standard deviations and marked with indices as described in Table 1.

These colour differences are used to assess bleeding of extracts according to Table 2. To qualify if bleeding is present after coating application (phase 1) the difference in brightness (ΔL^*_{P0}) on the samples shall be lower than the difference in brightness on the black/white contrast card (ΔL^*_{D}), both differences in brightness shall be negative values (because of the calculation defined in Table 1) and changes on the blue-yellow scale (Δb^*_{P0}) shall result in positive values. If these conditions are not fulfilled, measured colour differences shall be attributed to low opacity of the coating film and not to bleeding of extractives.

After cyclic climate exposure bleeding is present when the total colour difference on the stained surface (S) is larger than on the reference surface (R), the difference in brightness on the stained surface (S) is lower than on the reference surface (R) (both values shall be negative) and the difference on the blue-yellow scale (Δb^*) on the stained surface (S) is larger than on the reference surface (R). If these conditions are not fulfilled, measured colour differences shall be attributed to general yellowing of the coating film and not to bleeding of extractives in cyclic climate exposure.

Colour differences on the sample measured after coating application (phase 1) and after cyclic climate exposure (phase 2) may be used to quantify bleeding of extractives if the conditions above are fulfilled.

NOTE Colour differences on the red-green scale (Δa^*) are not relevant for bleeding of wood extractives.

Table 1 — Assessment of colour measurements in phases of extract bleeding; colour differences; end condition minus standard (regions R and S according to Figure 2)

Phase	Colour difference	CIELAB colour data		Index
		End condition	Standard	
Phase 1: Coating application	Colour difference on sample	S	R	P0
	Paint opacity	Contrast card black	Contrast card white	D
Phase 2: Climate exposure	Colour change in exposure	S after exposure	S before exposure	S
	General yellowing	R after exposure	R before exposure	R
	Colour difference on sample	S after exposure	R after exposure	PE

Table 2 — Assessment of colour measurements in phases of extract bleeding; qualification of bleeding of extracts

Phase 1: Coating application		**Phase 2: Climate exposure**			**Qualification of extract bleeding**	
Colour difference on sample	Paint opacity	Colour change in exposure	General yellowing	Colour difference on sample	Phase 1	Phase 2
ΔE^*_{P0}		ΔE^*_S	ΔE^*_R	ΔE^*_{PE}		$\Delta E^*_S > \Delta E^*_R$
ΔL^*_{P0}	ΔL^*_D	ΔL^*_S	ΔL^*_R	ΔL^*_{PE}	$\Delta L^*_{P0} < \Delta L^*_D < 0$	$\Delta L^*_S < \Delta L^*_R$ and $\Delta L^*_S < 0$
Δb^*_{P0}		Δb^*_S	Δb^*_R	Δb^*_{PE}	$\Delta b^*_{P0} > 0$	$\Delta b^*_S > \Delta b^*_R > 0$

6 Test report

The test report shall contain at least the following information:

a) reference to this specification;

b) name and address of the testing laboratory;

c) type of apparatus used;

d) identification number of the test report;

e) name and address of the organisation or the person who ordered the test;

f) date and person responsible for the sampling;

g) date of receipt of the coating system tested;

h) test results;

i) authorisation date of the test report.

Bibliography

[1] CEN/TS 16359, *Paints and varnishes - Coating materials and coating systems for exterior wood - Assessment of knot staining resistance of wood coatings*

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