Report
Revision 2

about the determination of the heat build-up of 9 films
Order number 202120156-UK07

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This report includes 5 pages.

Reason for the revision

Removal of material Mahogany-2 (MG12H) from “Materials” and “Results of the spectral measurement”.

Topic

The customer sent 9 films on the 22.03.2021 for preparation and the testing of the heat build-up.

Materials

1. Anthracite Gray (AG32H)
2. Mahogany-1 (MG11H)
3. Dark Walnut-2 (DWZ2H)
4. Dark Walnut-2 (DWZ2S)
5. Dark Walnut-3 (DW12S)
6. Golden Oak-4 (GOS2S)
7. Dark Walnut-2 (DWZ2X)
8. Dark Walnut-3 (DW12X)

Sample Preparation

The films were bonded to PVC panels white and black (base body) according to test method P.3.21 of the technical appendix to RAL-GZ 716 [1]. For this purpose, double-sided adhesive tape from HIT – HONER INDUSTRIETECHNIK (BRETZFELD-SCHEPPACH, GERMANY) were used. In Table 1, the technical information of the PVC panels and in Table 2, the information for the double-sided adhesive tape are listed.

Table 1: Technical Information of the PVC-U panels

Attribute	Value
Manufacturer	Röchling Engineering Plastics SE & Co. KG
Type	extruded, plasticizer-free PVC panels (PVC-U)
Brand name	Trovidur EC-N white 182 Trovidur EC-N black TR 712
Dimensions	72 mm x 72 mm x 2 mm
L*-Value Trovidur EC-N white 182	91.7
Carbon black content Trovidur EC-N black TR 712	3-4 %
Gloss value, 60°, Trovidur EC-N white 182	36.4 GU
Gloss value, 60°, Trovidur EC-N black TR 712	43.3 GU
HBU, Trovidur EC-N white 182	51.2 °C (Specification to [1] 51 °C ± 2 °C)
HBU, Trovidur EC-N black TR 712	73.7 °C (Specification to [1] 73.5 °C ± 0.5 °C)

The color measurement of the PVC panels was carried out according to ISO 11664-4 [2] and the gloss were determined according to ISO 2813 [3] in machine direction.

Table 2: Technical Information of the double-sided adhesive tape

Attribute	Value
Manufacturer	HIT – Honer Industrietechnik
Brand name	HDK 7408
Substrate	Polyester film
Thickness of the Substrate	12 µm
Total thickness	85 µm
Adhesive base	Synthetic rubber
Temperature range	-40 °C to +90 °C

Calculation of the Heat Build-Up

The calculation of the heat build-up (HBU) was carried out according to the current state of the test procedure "Determination of heat build-up of coloured surfaces" in section P.3.21 of the technical appendix to RAL-GZ 716 according to Eq. 1 as well as in consideration functional relationship of Eq. 2. The linear regression equation is given by five significant digits.

$$HBU = 0.0056807 \cdot I + 35.707 \qquad \text{Eq. 1}$$

$$I = \sum_{300\ nm}^{3500\ nm} [1 - R(\lambda)] \cdot S_\lambda \qquad \text{Eq. 2}$$

I ... Intensity

R_λ ... Reflectivity of a specific color

S_λ ... Relative spectral distribution of the IR lamp

The relative spectral distribution S_λ of the IR lamp (OSRAM SICCATHERM SICCA FR 250 W SG MATT 250 W / 230 V), used in the laboratory ("box") method, is taken as given and the intensity I (Eq. 2), as a measure of the absorbed radiation, calculated.
By correlating the experimental determined temperatures of different films in the "box method" with the corresponding intensities from the recorded UV/Vis/NIR spectra, the linear relationship mentioned in Eq. 1 could be developed by the company RENOLIT SE (WORMS, GERMANY). The graphic representation of the functional relationship is shown in Figure 1.

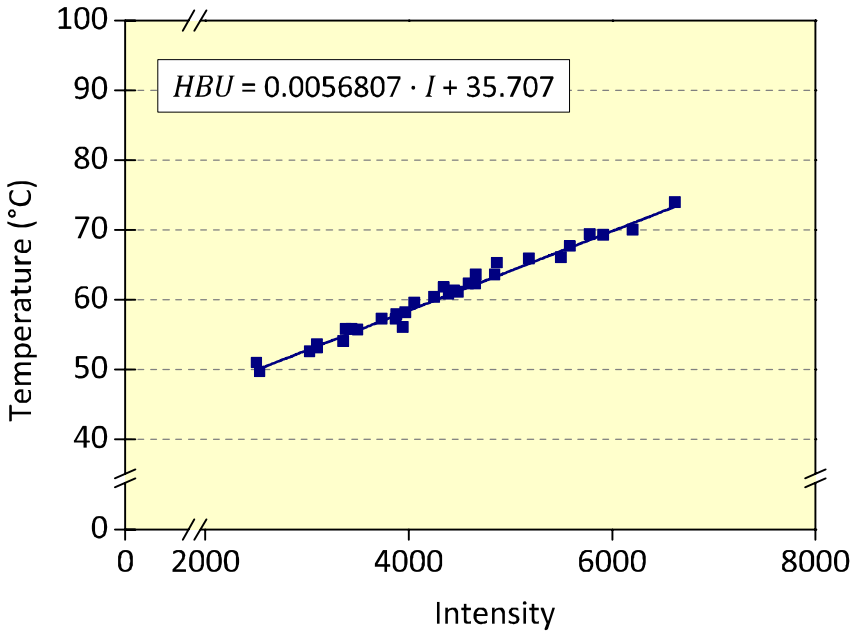

Figure 1: Linear regression of the functional relationship between laboratory experiments (measurements in the "box") and UV/VIS-NIR intensities; Results from company RENOLITE SE [1]

Results of the spectral measurement

Table 3 shows the results of the spectral measurements for all films. In accordance with the test procedure P.3.21, the calculated temperature should be round down at 4 and at 5 it should be rounded up. In the context of this test report, the temperatures are additionally indicated with one decimal place for a better interpretation of the results.
The value for the heat build-up of the films must not exceed 66 °C and is classified according to RAL-GZ 716 in class 1 to 3 (Table 4) [4].

Table 3: Results of the calculation of the head build-up

Name	Results of the spectral analysis		Heat build-up class	
	PVC white	PVC black	PVC white	PVC black
Anthracite Gray (AG32H)	61,1 °C	62,1 °C	2	2
Mahogany-1 (MG11H)	63,8 °C	64,5 °C	3	3
Dark Walnut-2 (DWZ2H)	56,4 °C	58,1 °C	1	2
Dark Walnut-2 (DWZ2S)	55,9 °C	57,7 °C	1	2
Dark Walnut-3 (DW12S)	56,6 °C	59,0 °C	1	2
Golden Oak-4 (GOS2S)	54,2 °C	57,4 °C	1	1
Dark Walnut-2 (DWZ2X)	56,0 °C	57,1 °C	1	1
Dark Walnut-3 (DW12X)	56,8 °C	59,2 °C	1	2

Table 4: Heat build-up classes

Class	Requirement heat build-up
1	≤ 57 °C
2	≤ 62 °C
3 (Minimum requirement)	≤ 66 °C

Literature

[1] RAL-GZ 716 (2018-07): Technical Appendix – Quality and Test Requirements for Components and Procedures – Section P Test Methods – P.3.21 Determination the heat build-up of coloured surfaces.

[2] ISO 11664-4 (2008-11): Colorimetry – Part 4: CIE 1976 L* a* b* Colour space.

[3] ISO 2813 (2014-10): Paints and varnishes – Determination of gloss value at 20 degrees, 60 degrees and 85 degrees.

[4] RAL-GZ 716 (2018-07): Technical Appendix – Quality and Test Requirements for Components and Procedures – Section D Films for the lamination of PVC-U window and door profiles – D.4.5 Heat build-up of the film