REPORT

Contract no.:	1096/2021 - HC (Translation of the original report of 26.05.2021)	15.03.2023 HAE/MID
Customer:	HASSLACHER Holding GmbH Feistritz 1 9751 Sachsenburg	
Subject:	Measurement of the emissions of VOC, formaldehyde and carbonyl compounds according to EN 16516 of a sample	
Date of contract:	16.02.2021	
Date of sample delivery:	02.04.2021	
Date/Period of service:	06.04. – 18.05.2021	
Period of validity:	---	
Pages:	13	
Enclosures:	Enclosure 1: Sampling Protocol	

1. Contract

On February 16th, 2021 Holzforschung Austria was commissioned with the testing of the VOC, formaldehyde and carbonyl compound emissions of a sample of glued laminated timber according to ÖNORM EN 16516.

Contact person: Mr. DI Georg Jeitler

1.1. Changes to report 1096/2021 of 18.05.2021

In section 3 "sample specification" a false product name was corrected.
Also, in section 3 the place of sample taking and the sample properties were elaborated.

2. Applied standards and guidelines

DIN ISO 16000-6 (2011): Indoor air — Part 6: Determination of volatile organic compounds in indoor and test chamber air by active sampling on Tenax TA sorbent, thermal desorption and gas chromatography using MS or MS-FID

ÖNORM EN ISO 16000-9 (2006 + Cor 1:2007): Indoor air — Part 9: Determination of the emission of volatile organic compounds from building products and furnishing — Emission test chamber method

ÖNORM EN ISO 16000-11 (2006): Indoor air — Part 11: Determination of the emission of volatile organic compounds from building products and furnishing — Sampling, storage of samples and preparation of test specimens

DIN ISO 16000-3 (2013): Indoor air — Part 3: Determination of formaldehyde and other carbonyl compounds in indoor and test chamber air — Active sampling method

ÖNORM EN 16516 (2018): Construction products - Assessment of release of dangerous substances - Determination of emissions into indoor air

Committee for Health-related Evaluation of Building Products (Ausschuss zur gesundheitlichen Bewertung von Bauprodukten - AgBB) – August 2018; Requirements for the Indoor Air Quality in Buildings: Health-related Evaluation Procedure for Emissions of Volatile Organic Compounds (VVOC, VOC and SVOC) from Building Products (with list of LCI values)

3. Sample specification

The sample was delivered to Holzforschung Austria on April 2nd, 2021. The specimens were packed airtight.

The sample consisted of 2 specimens of glued laminated timber made of spruce with the dimensions of 630 x 160 x 400 mm (L x W x H). The sample dimensions were calculated beforehand according to the specifications of EN 16516 for products used for ceilings (0.4 m^2/m^3).

The specimens were taken out of the ongoing production at the site of NORITEC Holzindustrie GmbH (part of HASSLACHER group) and were immediately packed airtight. According to Mr. DI Georg Jeitler the used glue DYNEA Prefere 4546/5022 is the same that is used in all other gluelam production sites of HASSLACHER group. For the sample the applied quantity of glue was 270 g/m^2 with a ratio of resin to hardener of 100:60 (weight proportions), which is also the normal operation mode for production of this product type.

Table 1 shows the properties of the received sample.

Table 1: Samples

HFA sample label	Product designation	Sample type	Dimensions [mm]	Production date
1096/2021	glued laminated timber	Spruce, glue DYNEA Prefere 4546/5022	630 x 160 x 400	01.04.2021

4. Test methods

The sample was tested in one of the 1.0 m^3 emission chambers of Holzforschung Austria.

The specimens were already cut to the above shown dimensions on delivery, so that a loading factor of 0.4 m^2/m^3 was reached, which is recommended in EN 16516 to be used for ceiling materials.

The edges were sealed with self-adhesive aluminium tape before placing the samples in the emission chamber (figure 1).

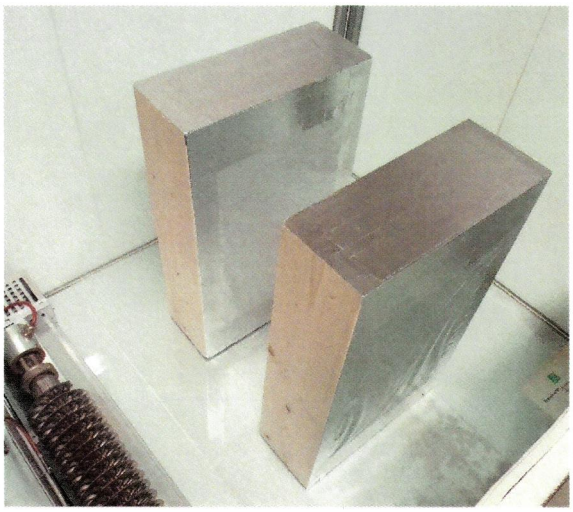

Figure 1: Sample 1096/2021 in the 1.0 m³ emission chamber

4.1. Emission chamber testing parameters

Table 2: Emission chamber testing parameters

Parameter	Value	Unit	Tolerance
Temperature	23	°C	± 1
Relative humidity	50	%	± 5
Air exchange rate	0.5	h^{-1}	± 0.015
Loading factor	0.4	m^2/m^3	
Area specific air flow rate q	1.25	m^3/hm^2	
Chamber volume	1	m^3	

Temperature and relative humidity conditions were met and recorded continuously during the entire test period.

4.2. Analysis of volatile organic compounds (VOC)

4.2.1. Sampling and analysis

For the sampling of VOC, a defined volume of emission chamber air is drawn through an adsorption tube filled with Tenax TA®, a porous polymer resin based on 2,6-diphenylene oxide. This material is suitable for the adsorption of volatile organic compounds of a chain length between C_6 (n-hexane) and C_{26} (hexacosane). According to the definitions of the WHO[1] this includes both VOC (volatile organic substances with boiling points between 50 °C and 250 °C) and SVOC (semi-volatile organic substances with boiling points between 250 °C and 390 °C).

Subsequent analysis of the Tenax TA®-Tubes is conducted according to ISO 16000-6 by use of a thermal desorption unit coupled to a gas chromatograph with mass spectrometric detection.

4.2.2. Calibration

Calibration standards, grouped by substance class, were prepared in methanol, injected on Tenax TA® tubes under inert gas conditions and analysed via the above described method. The calibration spans a range of approx. 1 - 250 µg/m for each substance.

4.2.3. Qualitative analysis

Identification of the detected substances is carried out by comparing the obtained chromatograms with mass spectra of commercial spectra libraries and the retention times and fragment ion spectra of commercially available standards.

4.2.4. Quantitative analysis

Substance specific quantification of individual compounds takes place by integrating the peak areas of target and qualifier ions using the above described calibration. Cyclodecane is used as an internal standard.

Substances not included in the calibration are quantified either via related substances or as toluene equivalents.

[1] World Health Organization, WHO (1989) – Indoor Air Quality: Organic Pollutants. Euro reports and studies, 11. Copenhagen, Regional Office for Europe.

4.3. Analysis of formaldehyde (and other carbonyl compounds)

4.3.1. Sampling on 2,4-Dinitrophenylhydrazine (DNPH) and analysis

A defined volume of emission chamber air is drawn through a cartridge containing DNPH. The principle of this procedure is based on the reaction of carbonyl groups with DNPH in acidic media, resulting in the formation of stable hydrazine-derivatives.

Subsequent analysis of the eluted compounds was conducted according to ISO 16000-3 by use of a high pressure liquid chromatography system with a diode array detector (absorption wavelength 360 nm).

4.3.2. Calibration

Commercially available standards were used to prepare a dilution series, which was analysed via the above described method. The calibration spans a range of approx. 1 - 610 µg/m³ for each substance.

4.3.3. Qualitative analysis

Identification of the detected compounds is carried out by comparison of their retention times with those of commercially available standards and information regarding the retention times of the substances on the used Acclaim Carbonyl C18 column.

4.3.4. Quantitative analysis

Substance specific quantification of individual compounds takes place by integrating the peak areas of the substances. To check the detector sensitivity a reference standard mix is analysed before the start of each series of measurements.

5. Results

Categorization of VVOC, VOC and SVOC was performed according to EN 16516 and based on the AgBB guidelines with the following scheme:

- VVOC substances within a retention range of < C_6
- VOC substances within a retention range of C_6-C_{16}
- $TVOC_{spec}$ sum of VOC substances with concentrations ≥5 µg/m³ quantitation by substance specific calibration according to EN16516 and. AgBB
- TVOC sum of VOC substances with concentrations ≥5 µg/m³ quantitation via toluene equivalents according to EN16516
- SVOC substances within a retention range of C_{16}-C_{22}
- TSVOC sum of SVOC substances with concentrations ≥5 µg/m³

In compliance with the AgBB guidelines, acetic acid, though eluting before C_6, is also included in the TVOC.
Carcinogenic substances (CARC 1A and CARC 1B, according to regulation (EC) No 1272/2008) are reported and included in the results starting from a concentration of 1 µg/m³.

All results are mean values resulting from repeat determinations (n=2).

As described in section 4 "Test methods" a loading factor of 0.4 m²/m³ was used for testing. The results in 5.1 are the concentrations in the chamber air (µg/m³) which were directly measured with this loading factor. With an air exchange rate of 0.5 h^{-1} the area specific air flow rate q is 1.25 m³/hm² for this setup.

In accordance with EN 16516 the concentration results are converted to the area specific emission rates SER (µg/m²h, see section 5.3). The SER results also correspond to the results with an area specific air flow rate q of 1.0 m³/hm² (unit: µg/m³).
For the calculation of the SER the following formula was used:

$$SER = \frac{c_i \; x \; AC}{L}$$

c_i: concentration in µg/m³
AC: hourly air change rate in the emission chamber h^{-1}
L: loading factor of the emission chamber m²/m³

In addition, the substance specific R_i values are calculated in accordance with the German AgBB guidelines, using the directly measured concentration results and the list of the "lowest concentrations of interest" (LCI values).

$$R_i = \frac{c_i}{LCI_i}$$

R_i: substance specific R value
c_i: determined concentration in µg/m³
LCI_i: specific LCI value of the substance

For the assessment of the total emissions of the sample on day 28, all substance specific R_i-values are summed up to the actual R value.

$$R = \sum R_i$$

For these calculations the updated LCI values of the AgBB guidelines 2018 were used.

To enable the comparison of the results with different guidelines the calculation of the R value was not only done with the actually measured concentrations at q=1.25 m³/hm² as is stated in the AgBB scheme, but also with the calculated results for q=1.0 m³/hm².

5.1. Results of measurements of VOC, SVOC and Formaldehyde at an area specific air flow rate q=1.25 m³/hm²

(actually measured concentrations in the chamber air)

Table 3: concentration results VOC, SVOC and Formaldehyde

Substance	CAS - No	Mean value Sample taking day 3		Mean value Sample taking day 28		Expanded uncertainty of the method
		Subst. spec. [µg/m³]	Toluol equiv. [µg/m³]	Subst. spec. [µg/m³]	Toluol equiv. [µg/m³]	
Acetic acid	64-19-7	12	6.8	35	7.5	± 40 %
Heptane	142-82-5	19	22	8.5	5.8	
Toluene	108-88-3	9.0	7.1	8.2	9.2	
Hexanal	66-25-1	10	< 5	6.7	< 5	
Alpha-Pinene	80-56-8	64	61	48	52	
Beta-Pinene	127-91-3	19	19	18	22	
Delta-3-Carene	13466-78-9	24	25	19	22	
Limonene	138-86-3	8.7	14	13	14	
branched alkane[a]	---	7.5	7.5	5.6	5.6	
not identified substance[a]	---	7.7	7.7	6.4	6.4	
Nonanoic acid[a]	112-05-0	< 5	< 5	8.3	8.3	
Decanoic acid[a]	334-48-5	< 5	< 5	6.9	6.9	
$TVOC_{spec}$		**181**	**---**	**184**	**---**	
TVOC		**---**	**170**	**---**	**160**	
TSVOC		**---**	**---**	**---**	**---**	
Formaldehyde	50-00-0	**7.3**		**4.4**		± 25 %
Acetaldehyde	75-07-0	**25**		**12**		

a quantified via toluene equivalents

5.2. Calculation of R value with the actually measured concentrations

Table 4: calculation of the R value at q=1.25 m³/hm²

Substance	CAS - No	Mean value Sample taking day 28 Substance spez. [µg/m³]	LCI values [µg/m³]	R_i values
Acetic acid	64-19-7	35	1200	0.03
Heptane	142-82-5	8.5	15000	0.0006
Toluene	108-88-3	8.2	2900	0.003
Hexanal	66-25-1	6.7	900	0.01
Alpha-Pinene	80-56-8	48	2500	0.02
Beta-Pinene	127-91-3	18	1400	0.01
Delta-3-Carene	13466-78-9	19	1500	0.01
Limonene	138-86-3	13	5000	0.003
branched alkane[a]	---	5.6	---	---
not identified substance[a]	---	6.4	---	---
Nonanoic acid[a]	112-05-0	8.3	---	---
Decanoic acid[a]	334-48-5	6.9	---	---
Formaldehyde	50-00-0	4.4	100	0.04
Acetaldehyde	75-07-0	12	1200	0.01
Sum Ri values/R value				**0.14**

5.3. Conversion of results to the area specific emission rates SER in accordance with EN 16516

Table 5: SER results VOC, SVOC and Formaldehyde

Substance	CAS - No	Mean value Sample taking day 3		Mean value Sample taking day 28		Expanded uncertainty of the method
		Subst. spec. [µg/m³]	Toluol equiv. [µg/m³]	Subst. spec. [µg/m³]	Toluol equiv. [µg/m³]	
Acetic acid	64-19-7	15	8.5	43	9.4	± 40 %
Heptane	142-82-5	24	27	11	7.3	
Toluene	108-88-3	11	8.9	10	11	
Hexanal	66-25-1	12	5.9	8.4	5.7	
Alpha-Pinene	80-56-8	80	76	60	65	
Beta-Pinene	127-91-3	24	24	23	27	
Delta-3-Carene	13466-78-9	30	32	23	27	
Limonene	138-86-3	11	18	17	17	
branched alkane[a]	---	9.4	9.4	7.0	7.0	
not identified substance[a]	---	9.6	9.6	80	8.0	
Nonanoic acid[a]	112-05-0	< 5	< 5	10	10	
Decanoic acid[a]	334-48-5	< 5	< 5	8.6	8.6	
$TVOC_{spec}$		**226**	**---**	**229**	**---**	
TVOC		**---**	**219**	**---**	**203**	
TSVOC		**---**	**---**	**---**	**---**	
Formaldehyde	50-00-0	**9.1**		**5.4**		± 25 %
Acetaldehyde	75-07-0	**31**		**15**		

a quantified via toluene equivalents

5.4. Calculation of R value with the calculated results for q= 1.0 m³/hm² (equivalent to SER)

Table 6: calculation of the R value at q=1.0 m³/hm²

Substance	CAS - No	Mean value Sample taking day 28 Substance spez. [µg/m³]	LCI values [µg/m³]	R_i values
Acetic acid	64-19-7	43	1200	0.04
Heptane	142-82-5	11	15000	0.0007
Toluene	108-88-3	10	2900	0.003
Hexanal	66-25-1	8.4	900	0.01
Alpha-Pinene	80-56-8	60	2500	0.02
Beta-Pinene	127-91-3	23	1400	0.02
Delta-3-Carene	13466-78-9	23	1500	0.02
Limonene	138-86-3	17	5000	0.003
branched alkane[a]	---	7.0	---	---
not identified substance[a]	---	8.0	---	---
Nonanoic acid[a]	112-05-0	10	---	---
Decanoic acid[a]	334-48-5	8.6	---	---
Formaldehyde	50-00-0	5.4	100	0.05
Acetaldehyde	75-07-0	15	1200	0.01
Sum Ri values/R value				**0.18**

6. Storage of samples

Samples will be kept in storage for a period of 3 months after completion of the measurements.

HOLZFORSCHUNG AUSTRIA

DI (FH) Christina Fürhapper
Authorisation to sign

Mag. Elisabeth Habla
Technical execution

This report was approved electronically in accordance with an internal HFA process by the designated authorized signatory, traceable and documented.

Accreditation is given for the following procedures.
It is not allowed to use included accreditation marks for own purposes.

Accreditation mark	Type of accreditation	Procedure/s
Akkreditierung Austria A 0055 ISO/IEC 17025 T	testing	• DIN ISO 16000-6 • ÖNORM EN ISO 16000-9 • ÖNORM EN ISO 16000-11 • DIN ISO 16000-3 • ÖNORM EN 16516

The results and statements given in this document relate only to the tested materials as received, the present information and the state of the art at the time of investigation.

Publication in excerpts is only permitted with the written approval of Holzforschung Austria.

The conformity assessment of the results is subject to the shared-risk approach.