REPORT

issued by an Accredited Testing Laboratory

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Emission measurements according to M1

(3 appendices)

Assignment

Emission measurement according to "M1 Emission Classification of Building Materials: Protocol for Chemical and Sensory Testing of Building Materials", ver 15.11.2017, after 28 days of conditioning regarding volatile organic compounds, carcinogenic compounds (EU Regulation No 1272/2008 Annex VI, cat 1A and 1B), formaldehyde, ammonia and sensory acceptability.

Product/test specimen

Table 1.

Product type:	Plywood panel
Product name:	**Poplar Plywood BB/CC**
Batch No:	--
Manufacturing date:	2020-12-20
Packaging:	Eight pieces of 600 x 600 mm, 9 mm thickness. Wrapped in aluminium foil and plastic foil.
Arrived at RISE:	2021-01-12
Test specimen preparation:	Wall scenario is used for the testing. Chemical testing: Two pieces were used. They were placed back-to-back, edges and small parts of front sides were sealed with aluminium tape, total surface area of 0.70 m^2 Sensory testing: Five pieces were used. They were placed back-to-back, two-and-two, one piece backside covered with aluminium foil. Edges and small parts of front sides were sealed with aluminium tape, total surface area of 1.7 m^2.
Deviation from protocol:	No
Test period started, date:	2021-01-13
Conditions during ageing:	23 ± 2 ºC, 50 ± 5 % RH
Emission samplings, date:	2021-02-10

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Methods

The specimens were conditioned outside the testing chambers in separate conditioning containers (with air velocity of ca 0.2 m/s) in a room with controlled climate conditions of 23 ± 2 ºC and 50 ± 5 % RH. The specimens were placed in the chambers five days before the measurements of the chemical emission and five days before the sensory evaluation.

Table 2.
Chamber conditions of the test of chemical emissions

Test chamber volume:	1.0 m^3, stainless steel
Temperature:	23 ± 1 ºC
Relative Humidity:	50 ± 3 % RH
Air exchange rate:	0.68 h^{-1}
Air velocity at specimen surface:	0.1 – 0.3 m/s
Area of sample:	0.70 m^2
Area specific air flow rate:	0.72 m^3/m^2h

Table 3.
Chamber conditions of the test of sensory acceptability

Test chamber volume:	1.0 m^3, stainless steel
Temperature:	23 ± 1 ºC
Relative Humidity:	50 ± 3 % RH
Supply air flow rate:	0.9 l/s = 3.2 m^3/h
Area of sample:	1.7 m^2

Table 4.
Emission sampling and analytical methods

Test	**Sampling method**	**Adsorbent**	**Sampling volume (litre)**	**Analysis method / Quantification**	**Detection limit**
VOC	ISO 16000-9:2006 [1]	Tenax TA	2 - 6	RISE 0601 [2] / FID quantification	1 µg/m^3
Formaldehyde	ISO 16000-9:2006 [1]	DNPH	60	RISE 2303[3]/HPLC-UV	0.03 µg/sampler
Ammonia	ISO 16000-9:2006 [1]	Treated silica gel	110, 160	Liquid chromatograph with conductivity detector [4]	0.9 µg/sampler
Sensory evaluation	ISO 16000-28:2012 [5]	--	--	Acceptability, Untrained panel of min 15 persons	--

[1)] In accordance with ISO 16000-9:2006 and M1 protocol.
[2)] In accordance with ISO 16000-6:2011 and M1 protocol.
[3)] In accordance with ISO 16000-3:2001.
[4)] Not accredited method.
[5)] In accordance with M1 protocol, not accredited method.

Tenax TA was used as adsorption medium for VOC The tubes were thermally desorbed and analysed in accordance to RISE method 0601, similar to ISO 16000-6:2011 (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/FID). This means an analysis in a gas chromatograph and detection with a flame ionisation detector (FID) and mass selective detector (MS). The FID signals are used for compound quantification. The TVOC is quantified as toluene equivalents. The mass selective detector is used for identification of compounds.

The capillary column used is coated with 5% phenyl/ 95 % methylpolysiloxane. Tenax TA was also used as adsorption medium for testing of volatile carcinogenic compounds, according to EU Regulation No 1272/2008 Annex VI, cat 1A and 1B), (exclusive formaldehyde), 0.001 mg/m^3 and above.

The sampling of formaldehyde was carried out with DNPH samplers. The samplers were analysed according to RISE method 2302, similar to ISO 16000-3:2011(Indoor air--Part 3: Determination of formaldehyde and other carbonyl compounds – Active sampling method), which means analysis on a liquid chromatograph with absorbance detector.

The sampling of ammonium was carried out with silicagel treated adsorbent tubes and analysis on a liquid chromatograph with conductivity detector.

Minimum two subsequent samples were taken for the VOC determination, for the formaldehyde and for the ammonia respectively.

Results

The results relate only to the items tested. Decision rule: When comparing the measured results and requirement level, the average value of the measured results has been compared with the requirement level. No account is taken to the measurement uncertainty.

The results of the chemical testing are expressed as area specific emission rates and as concentrations in a model room. The model room has a base area of 3 m x 4 m and a height of 2.5 m, with an air exchange rate of 0.5 h^{-1}. The wall area is 31.4 m^2, floor area is 12 m^2, small area, like a door, is 1.6 m^2 and very small area, like sealant, is 0.2 m^2. Wall area is used for the calculation of the concentrations.

Calculation of the concentration from the emission rate:

$$Conc = \frac{SER_A \times A}{n \times V}$$

Conc = concentration of a VOC in the model room, in µg/m^3
SER_a = area specific emission rate, in µg/m^{2}h
A = area of sample, in m^2
n = air exchange rate, in changes per hour
V = volume of the model room, in m^3

Table 5.
Results of the chemical testing of **Poplar Plywood BB/CC** after 28 days

Compound	**Concentration in model room** mg/m^3	**Emission rate** mg/m^{2}h	**Criteria M1** mg/m^{2}h
TVOC [6]	0.038	**0.018**	< 0.2
Carcinogens	< 0.001	**< 0.001**	< 0.001
Single VOC (µg/m^3)	**≤ EU-LCI**	**--**	≤ EU-LCI
Formaldehyde	0.012	**0.006**	< 0.05
Ammonia [7]	< 0.013	**< 0.006**	< 0.03

[6)] The TVOC is the sum of the individual concentration ≥ 5 µg/m^3 in model room.
[7)] Not accredited method.

Table 6.
Results of the sensory acceptability evaluation of the sample **Poplar Plywood BB/CC**, after 28 days

Evaluator	Sensory evaluation	Criteria M1
1	0.50	
2	0.95	
3	0.95	
4	0.95	
5	0.30	
6	0.60	
7	0.45	
8	0.85	
9	0.40	
10	0.95	
11	0.50	
12	0.55	
13	0.65	
14	0.65	
15	0.55	
Arithmetic mean of acceptability [8]	**0.65**	≥ + 0.0
Standard deviation	0.22	
90 % confidence interval of arithmetic mean	0.10	≤ 0.2

[8)] Not accredited method.

The empty sensory test chamber acceptability was determined 2021-02-05. The mean acceptability vote of the empty chamber was ≥ 0.8.

Interpretation of the results

The tested product **Poplar Plywood BB/CC** complies with all the requirements of M1 for the tested parameters.

Detailed results

Table 7.
Detailed results (emission rates) of the chemical testing after 28 days

Sample	TVOC (mg/m^2h) as toluene equivalents between C_6-C_{16}	Formaldehyde (mg/m^2h)	Ammonia (mg/m^2h)	Carcinogens (mg/m^2h) between C_6-C_{16}
1	0.021	0.006	< 0.006	< 0.001
2	0.016	0.006	< 0.006	< 0.001

Table 8.
Single VOCs above 5 µg/m^3 in the model room

Single VOCs	CAS number	Retention time (min)	ID [9]	Emission rate (µg/m^{2}h)	Concentration (µg/m^3)
Single VOCs C_6-C_{16}:	--	6.2 - 38			
Acetic acid (VVOC)	64-19-7	5.6	B	18	38
TVOC	--	6.2 - 38	B	18	38
Volatile Carcinogens [10]		6.2 - 38			
No substances detected	--	--	B	< 1	< 1
Single VOC outside C_6 – C_{16}:					
VVOC (< C_6) [11]		5.3 – 6.2			
No single VVOC detected	--	--	B	< 2	< 5
SVOC (C_{16} – C_{22}) [12]		38 - 51			
No single SVOC detected	--	--	B	< 2	< 5

9) ID: A = quantified compound specific, B = quantified as toluene-equivalent
10) Volatile carcinogens = VOCs according to EU Regulation No 1272/2008 Annex VI, cat 1A and 1B
11) VVOC = very volatile organic compounds, as defined in ISO 16000-6 (not accredited)
12) SVOC = semi-volatile organic compounds, as defined in ISO 16000-6 (not accredited)

TVOC is the sum of all individual substances with concentrations ≥ 5 µg/m^3 (in toluene equivalents).

Level of identification of compounds is 100 % for all compounds ≥ 5 µg/m^3.

Table 9.
Detected EU LCI-compounds ≥ 5 µg/m^3 quantified by compound specific response factor

Single VOCs	CAS number	Retention time (min)	ID	Concentration (µg/m^3)	EU LCI$_i$ (Dec 2019) (µg/m^3)
Single VOCs C_6-C_{16}:		6.2 - 38			
Acetic acid (VVOC)	64-19-7	5.6	A	**100**	1200

9) ID: A = quantified compound specific, B = quantified as toluene-equivalent

Measurements uncertainty

The expanded measurement uncertainty of VOC result is 15 % (rel) and formaldehyde is 30 % (rel). For ammonia the measurement uncertainty is estimated to 20 % (rel).

See Appendix 1 for a gas chromatogram from the VOC determination and Appendix 2 for a photo of the test specimens. Appendix 3 is the Sampling report received from the customer.

RISE Research Institutes of Sweden AB
Materials and Production – Chemical and Biological Safety

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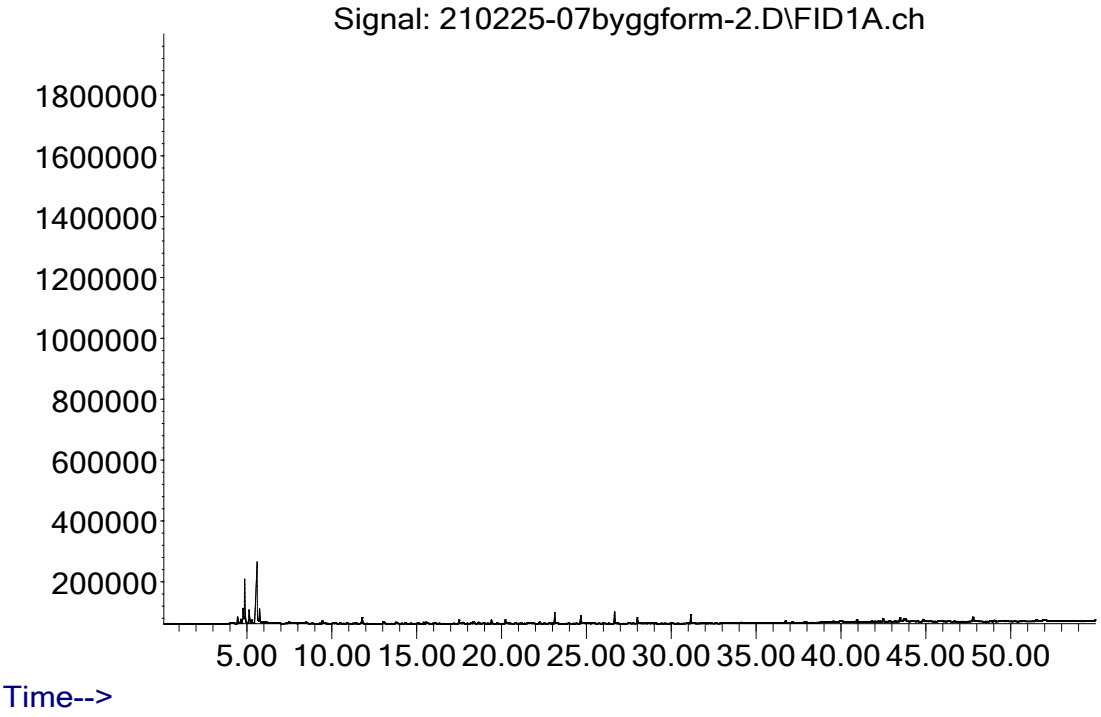
Appendices

1. Gas Chromatogram
2. Photo of test specimen
3. Sampling report

Appendix 1

Gas chromatogram

Sample: **Poplar Plywood BB/CC**, after 28 days



TVOC between C_6 and C_{16}, means compounds eluting between 6.2 and 38 minutes.

Appendix 2

Photo of test specimen

The test specimen of the chemical test.

Appendix 3

Sampling Report

Sampler (Name, Company, contact info): ByggForm AS Eternitveien 8 NO-3470 Slemmestad, Norway Att: Herulf Espenæs Phone: +47 90551630 e-mail: Herulf.espenes@byggma.no	**Manufacturer of the product** (Company, address): LINYI QIUZHEN WOOD INDUSTRY CO.,LTD
Name of product: POPLAR PLYWOOD BB/CC	**Type of product:** PLYWOOD PANELS, WBP-E1
Manufacturing Date: 20.12.2020	**Batch No:**
Date of sampling: 25.12.2020	**Amount/size of material sampled:** 9X600X600MM, 8 pcs **Packing material: Plastic foil.**
Sample is taken from: Production line X Stock / Storage ☐ Miscellaneous ☐	**How was the product stored before sampling?** After production, the product was cooled down and cut down to samples, before samples were prepared for shipment.
If a sub-sample was collected from a larger material amount, describe how the sub-sample was taken:	
Observations and remarks:	
Confirmation I hereby confirm that the sample was selected, taken and packed in accordance with the instructions.	
Date: 12.01.2021	**Signature:** Herulf Espenæs