BELGIAN BUILDING RESEARCH INSTITUTE
INSTITUTION RECOGNISED BY APPLICATION OF THE DECREE-LAW OF 30 JANUARY 1947

All tests in this report are executed according to the ISO 9001 certified Quality management system of the BBRI.

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TEST REPORT

Laboratory	BUILDING CHEMISTRY (CH)	**O/References**	DE-CH-0271 CH-20-191-01 Page 1/3

Requested by	**Gramitherm Europe SA** Mr. Florian Grosjean Rue des Glaces Nationales 87 5060 Auvelais		
Date of the order	21/10/2019	**Sample registration**	S-2020-51-002
		Date of reception of samples	22/10/2020
Date of issue of the report	16/12/2020		
Test carried out	Determination of the VOC emission rate of a bio-based insulation board from meadow grass of the type **« GRAMITHERM 240MM »**		
References	• *NBN EN ISO 16000-9 (2006)* *Test chamber methodology* • *ISO 16000-6 (2011)* *Analysis of the individual VOCs and TVOC* • *ISO 16000-3 (2011)* *Analysis of formaldehyde and acetaldehyde*		

Disclaimer
The laboratory is not responsible for the accuracy and completeness of the information provided by the customer and taken over in this report. The sampling was not carried out by the laboratory and thus the results of this report apply only to the sample as received by the laboratory. The equivalence between the tested product covered by this report and the commercialised product lies entirely under the responsibility of the requestor.

This test report contains 3 pages. This test report may only be reproduced in its entirety. Each page of the original report has been stamped (in red) by the laboratory and initiated by the head of laboratory.

- ❑ *No sample*
- ❑ *Sample(s) subjected to destructive test*
- ☑ *Sample(s) to be removed from our laboratories 30 calendar days after sending of the report, save in the case of a further written request.*

Technical responsible of the test	Responsible in charge of the test	Head of laboratory
Fabrice Graindorge	Tom Haerinck	P. Steenhoudt

QUICK EVALUATION OF THE TEST RESULTS

Regulation	« Gramitherm 240MM »	Version of regulation
French VOC regulation	ÉMISSIONS DANS L'AIR INTÉRIEUR A+ A+ A B C	*"Décret no 2011-321 du 23 mars 2011 (DEVL1101903D)" and "Arrêté du 19 avril 2011 (DEVL2204875A)"*

Further details and comparison with the limit values are available in the following pages of this test report.

1 TEST

Determination of the VOC emission rate of a bio-based insulation board from meadow grass of the type **« GRAMITHERM 240MM »**.

2 SAMPLE

The test sample consist of a bio-based insulation board from meadow grass of the type **« GRAMITHERM 240MM »** with a surface area of 0.235 m^2 (480 x 490 mm) and a thickness of 240 mm.

The test sample has been sampled and deliverd to the testing laboratirum in an airtight package by the client. The sampling form is shown in Annex 1.

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In the testing laboratorium the sample was stored in the airthight package prior to the emission testing. Just before starting the testing, the bottom and sides of the test samples were covered using aluminium foil, leaving just the upper face exposed to the test chamber air.

3 TEST RESULTS

3.1 *Principle of a VOC emission test*

In a VOC emission test, a test sample is placed in an emission test chamber with standardised environmental parameters (temperature, relative humidity, air exchange rate and air speed). The area of the test piece is also standardised in function of the volume of the test chamber (i.e. the loading factor L[1]). The test chamber is ventilated with purified compressed air. After a specific period (usually 28 days), air samples are taken from the test chamber air.

From the concentration of volatile organic compounds (VOC) in the test chamber air, the specific emission rate (SER) for each component can be determined. This quantity is expressed as the mass of VOC emitted per surface and time unit [µg/(m^2.h)].

The specific emission rate is subsequently converted to the VOC concentration that the material would cause if it is (theoretically) installed in a reference room (without any other VOC sources present). This reference room, its environmental parameters, and the loading factors for different types of construction and finishing materials are described in different test standards for emission chamber measurements. The VOC emission level is expressed in this way as the mass of VOC per volume of air in the reference chamber [µg/m^3].

$$C_r = \frac{C_t \times A_t \times L_r}{L_t \times A_r}$$

With	C_r	Concentration in the theoretic reference room of ISO 16000-9	(µg/m^3)
	C_t	Concentration measured in the test chamber	(µg/m^3)
	A_t	Air exchange rate in the test chamber	(h^{-1})
	L_t	Loading factor of the test sample in the test chamber	(m^2/m^3)
	A_r	Air exchange rate in the theoretic reference room of ISO 16000-9	(0.5 h^{-1})
	L_r	Loading factor of a wall covering in the theoretic reference room	(1.0 m^2/m^3)

[1] The loading factor L is equal to the ratio of the surface area of the test sample to the volume of the emission test chamber.

3.2 *References and specifications of the test chamber methodology*

Procedure	Method	Analytical principle	Quantification limit
Sample preparation	NBN EN ISO 16000-11: 2006	-	-
Chamber testing	NBN EN ISO 16000-9: 2006	-	-
VOC sampling	ISO 16000-6: 2011	Tenax TA	-
VOC analysis (+ calculation TVOC)	ISO 16000-6: 2011	TD-GC-MS	1 µg/m^3
Aldehyde sampling	NF ISO 16000-3: 2011	2,4-DNPH	-
Aldehyde analysis	NF ISO 16000-3: 2011	HPLC-UV	1 µg/m^3
Calculation VOC concentrations in the reference chamber	NBN EN ISO 16000-9: 2006	-	-

3.3 *Emission test chamber parameters*

TEST CHAMBER PARAMETERS					
Test scenario	**Wall covering= 1 m^2 sample surface area per 1 m^3 test chamber air**				
Test chamber volume	0.250 m^3	Air flow	125 ml/min	Loading factor	0.94 m^2/m^3
Sample test surface	0.235 m^2	Air exchange rate	0.5 h^{-1}	Specific air flow	0.53 m^3/m^{2}h
Temperature	23°C ± 1°C	Relative humidity	50 ± 5 %	Air velocity	0.15 m/s
VOC SAMPLING PARAMETERS (2 AIR SAMPLES)					
Timing	After 28 days	Volume of air	4,8 l	Sampling air flow	160 ml/min
ALDEHYDE SAMPLING PARAMETERS (2 AIR SAMPLES)					
Timing	After 28 days	Volume of air	60 l	Sampling air flow	1000 ml/min

3.4 *Date of testing*

- Start of the emission test: 27 October 2020
- Sampling of the VOC and aldehyde components: 24 November 2020
- Analysis individual VOC and TVOC (by GC-MS): 27 November 2020
- Analysis formaldehyde and acetaldehyde (by HPLC): 30 November 2020

3.5 *VOC emission rate results after 28 days*

The results obtained for the VOC emission rate (concentration in the theoretic reference room of ISO 16000-9), after 28 days with the test scenario 'wall' of the biobased insulation board of the type **« GRAMITHERM 240MM »** are shown in Table 1.

Table 1: *VOC emission rate of the biobased insulation board* ***« GRAMITHERM 240MM »***

Component	**Cas n°**	**Retention time** (min)	**Emission rate** (µg/m³)
Formaldehyde	50-00-0	-	4
Acetaldehyde	75-07-0	-	31
TVOC		-	17
Toluene	108-88-3	10.36	4
Tetrachloroethylene	127-18-4	12.30	< 1
Ethylbenzene	100-41-4	14.76	< 1
Xylene (m-,p- & o-)	1330-20-7	15.12 & 16.19	< 1
Styrene	100-42-5	16.09	< 1
2-Butoxyethanol	111-76-2	16.78	< 1
1,2,4-Trimethylbenzene	95-63-5	20.49	< 1
1,4-Dichlorobenzene	106-46-7	21.24	< 1

3.6 *Comparison with the limit values of the French VOC regulation*

Tables 2 provides a comparison of the VOC emission rates, obtained after 28 days, to the limit values of the French VOC regulation: *"Décret no 2011-321 du 23 mars 2011 (DEVL1101903D)" and "Arrêté du 19 avril 2011 (DEVL2204875A)".*

Table 2: *Comparison of the obtained emission rate and French VOC limit values for* ***« GRAMITHERM 240MM »***

Component	**Cas n°**	**Emission rate after 28 days** (µg/m³)	A+ (µg/m³)	A (µg/m³)	B (µg/m³)	C (µg/m³)
TVOC	-	17	< 1000	< 1500	< 2000	> 2000
Formaldehyde	50-00-0	4	< 10	< 60	< 120	> 120
Acetaldehyde	75-07-0	31	< 200	< 300	< 400	> 400
Toluene	108-88-3	4	< 300	< 450	< 600	> 600
Tetrachloroethylene	127-18-4	< 1	< 250	< 350	< 500	> 500
Ethylbenzene	100-41-4	< 1	< 750	< 1000	< 1500	> 1500
Xylene (m-,p- & o-)	1330-20-7	< 1	< 200	< 300	< 400	> 400
Styrene	100-42-5	< 1	< 250	< 350	< 500	> 500
2-Butoxyethanol	111-76-2	< 1	< 1000	< 1500	< 2000	> 2000
1,2,4-Trimethylbenzene	95-63-5	< 1	< 1000	< 1500	< 2000	> 2000
1,4-Dichlorobenzene	106-46-7	< 1	< 60	< 90	< 120	> 2000

Note: *The French decree no. 2011-321 (from 23 March 2011) determines that the party who distributes a product on the French market, is the only responsible for correctly assigning the VOC emission class of the product.*