REPORT
issued by an Accredited Testing Laboratory

Contact person	Date	Reference	Page
Maria Rådemar SP Chemistry, Materials and Surfaces +46 10 516 51 65 maria.rademar@sp.se	2013-04-29	3P02063-3	1 (5)

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ISO/IEC 17025

Forbo Flooring AB
Robert J ürke
Box 9046
400 91 GÖTEBORG

Emission measurements

(1 appendix)

Assignment

At the request of Forbo Flooring AB an emission measurement according to “Emission Classification of Building Materials: Protocol for Chemical and Sensory Testing of Building Materials”, ver 15.12.2004, has been carried out.

The measurements are made after 28 days of conditioning regarding volatile organic compounds, formaldehyde, ammonia and odour.

Product/test specimen

Product type:	Flooring
Product name:	**Marmoleum Real**
Batch No:	Dessin 3038, Batch 79218, Roll no 207
Manufacturing date:	2013-01-22
Packaging:	One roll 1 x 1.5 m
Arrived at SP:	2013-02-28
Test specimen preparation:	Chemical testing: Two pieces of 0.31 x 0.50 were cut out. They were placed back-to-back with aluminium foil in between and edges were sealed with aluminium tape. Also parts of front sides were sealed. Total surface area = 0.28 m^2. Sensory testing: Seven pieces of 0.20 x 0.50 were cut out. They were placed back-to-back and edges were sealed with aluminium tape. Also parts of front sides were sealed. Total surface area = 0.68 m^2.
Deviation from protocol:	No deviations
Test period started, date:	2013-03-11
Conditions during ageing:	23 ± 2 ^{o}C, 50 ± 5 % RH
Emission samplings, date:	2013-04-09

Methods

The specimens were conditioned outside the testing chambers in controlled climate conditions of 23 ± 2 ^{o}C and 50 ± 5 % RH. The specimens were placed in the chambers two days before the measurements of odour resp chemical emission.

SP Technical Research Institute of Sweden

Postadress	*Besöksadress*	*Tfn / Fax / E-post*	
SP Box 857 SE-501 15 BORÅS Sweden	Västeråsen Brinellgatan 4 SE-504 62 BORÅS	+46 10 516 50 00 +46 33 13 55 02 info@sp.se	Laboratorier ackrediteras av Styrelsen för ackreditering och teknisk kontroll (SWEDAC) enligt svensk lag. Denna rapport får endast återges i sin helhet, om inte utfärdande laboratorium i förväg skriftligen godkänt annat.

Chamber conditions of the test of volatile organic compounds, formaldehyde and ammonia:

Test chamber volume:	1.0 m^3, stainless steel
Area of sample:	0.28 m^2
Air exchange rate:	0.5 h^{-1}
Area specific air flow rate:	1.8 m^3/m^2h
Temperature:	23 ± 1 °C
Relative Humidity:	50 ± 3 % RH

Chamber conditions of the test of odour:

Test chamber volume:	0.051 m^3, glass (Climpaq)
Area of sample:	0.68 m^2
Supply air flow rate:	0.9 l/s = 3.24 m^3/h
Temperature:	23 ± 1 °C
Relative Humidity:	50 ± 3 % RH

Emission sampling and analytical methods:

Test	**Sampling method**	**Adsorbent**	**Sampling volume (litre)**	**Analysis method / Quantification**	**Detection limit**
VOC	SP 1314[1]	Tenax TA	5 - 9	SP 0601 [2] / FID quantification	1 µg/m^3
Formaldehyde	SP 1314[1]	DNPH	70 - 110	SP 2303[3] / HPLC-UV	0.03 µg/sampler
Ammonia	SP 1314[1]	Silica gel	205, 224	Liquid chromatograph with conductivity detector [4]	0.9 µg/sampler
Sensory evaluation	Human nose	--	--	--	--

1) In accordance with ISO 16000-9:2006, accredited method.
2) In accordance with ISO 16000-6:2004, accredited method.
3) In accordance with ISO 16000-3:2001, accredited method.
4) The determinations of the sampled silica gel tubes were done by Sahlgrenska Universitetssjukhuset, Miljökemiska laboratoriet, Göteborg, not accredited method.

Tenax TA was used as adsorption medium for VOC. The Tenax tubes were thermally desorbed and analysed in accordance to ISO 16000-6:2004 (Determination of volatile organic ompounds in indoor and test chamber air by active sampling on Tenax TA sorbent, thermal desorption and gas chromatography using MS/FID), accredited SP method 0601. 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.

Tenax TA was also used as adsorption medium for testing of volatile carcinogenic compounds, according to IARC listing, category 1 (exclusive formaldehyde), 0.001 mg/m^2h and above.

The sampling of formaldehyde was carried out with DNPH samplers. The samplers were analysed according to ISO 16000-3 (in accordance to accredited SP method 2302), 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.

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

Results

The results of the chemical testing are expressed as concentrations in the chamber and area specific emission rates:

$$SER_A = \frac{Conc \times n}{L}$$

SER_a = area specific emission rate, in mg/m^2h
Conc = concentration of a volatile compound in the chamber, in mg/m^3
n = air exchange rate, in changes per hour
L = loading factor, in m^2/m^3 (area of sample/volume of chamber)

Results of the chemical testing of the sample of **Marmoleum Real** after 28 days:

Compound	**Concentration** mg/m^3	**Emission rate** mg/m^2h	**Criteria M1** mg/m^2h
TVOC	< 0.006	**< 0.010**	< 0.2
Carcinogens	< 0.002	**< 0.002**	< 0.005
Formaldehyde	< 0.002	**< 0.004**	< 0.05
Ammonia	< 0.004	**< 0.008**	< 0.03

See appendix 1 for gas chromatograms from VOC determination.

Results of the sensory evaluation of the sample of **Marmoleum Real** after 28 days:

Evaluator	**Sensory evaluation**		**Average of acceptability**	**Criteria M1**
	first	second		
1	1.00	1.0	**0.7**	≥ + 0.1
2	0.70	0.71		
3	0.39	0.45		
4	0.78	0.74		
5	0.57	0.58		
6	0.79	0.79		

Standard deviation of the sensory evaluation of the test sample was 0.19.

The empty sensory test chamber acceptability was determined 2013-04-05. The mean acceptability vote of the empty chamber was > 0.5.

Interpretation of the results

The tested product **Marmoleum Real** complies with all the requirements of M1 for the tested parameters.

Detailed results

Detailed results of the chemical testing after 28 days:

Sample	**TVOC** (mg/m^{2}h) as toluene equivalents between C_6-C_{16}	**Formaldehyde** (mg/m^{2}h)	**Ammonia** (mg/m^{2}h)	**Carcinogens** [5] (mg/m^{2}h) as toluene equivalents between C_6-C_{16}
1	< 0.010	< 0.004	< 0.008	< 0.002
2	< 0.010	< 0.004	< 0.007	< 0.002
3	< 0.010	--	--	< 0.002

5) The emission of which exceeds 0.002 mg/m^{2}h.

Single VOCs:

Single VOCs of which exceed 0.005 mg/m^{2}h as toluene equivalent	**Retention time** (min)	**CAS number**	**Emission rate** (mg/m^{2}h)		
			Sample 1	**Sample 2**	**Sample 3**
Single VOCs C_6-C_{16}:	5.2 – 36.3				
No single VOC detected	--	--	--	--	--
		TVOC:			
Single VOC outside C_6 – C_{16}:					
VVOC (< C_6) [6]	3.5 – 5.2				
No single VVOC detected	--	--	--	--	--
SVOC (C_{16} – C_{22}) [7]	36.3 - 44.0				
No single SVOC detected	--	--	--	--	--

6) VVOC = very volatile organic compounds, as defined in ISO 16000-6 (not accredited)
7) SVOC = semi-volatile organic compounds, as defined in ISO 16000-6 (not accredited)

Level of identification of compounds is 100 % for all compounds ≥ 0.005 mg/m^{2}h.

Measurements uncertainty

SER_{TVOC}: ± 15 %, $SER_{Formaldehyde}$: ± 30 %, SER_{NH3}: ± 14 %

SP Technical Research Institute of Sweden
SP Chemistry, Materials and Surfaces - Chemistry

Performed by	Examined by
Maria Rådemar	Marcus Vestergren

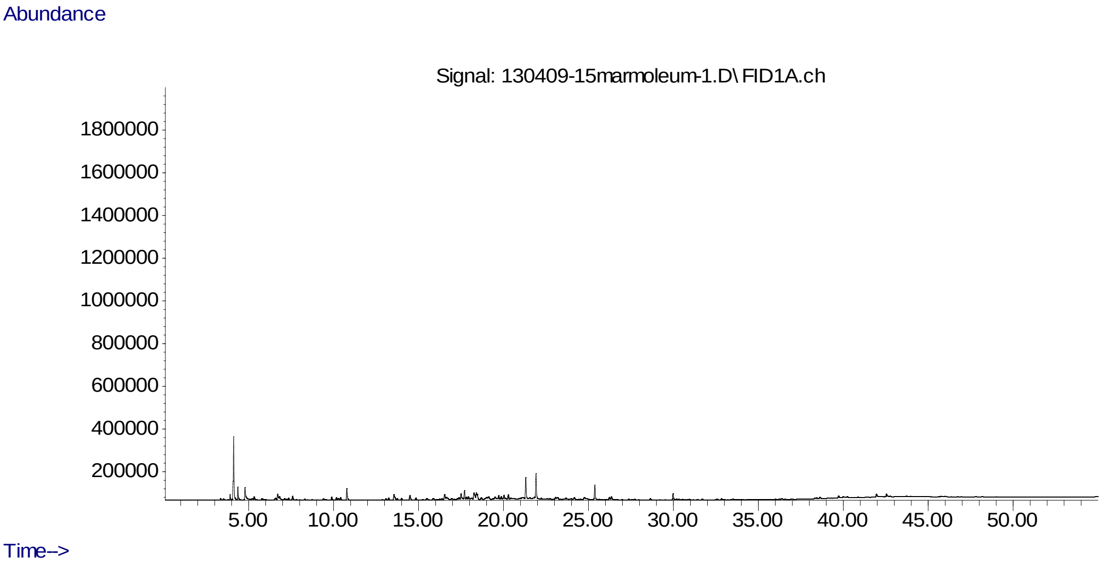
Appendix

1. Gas Chromatograms

Appendix 1

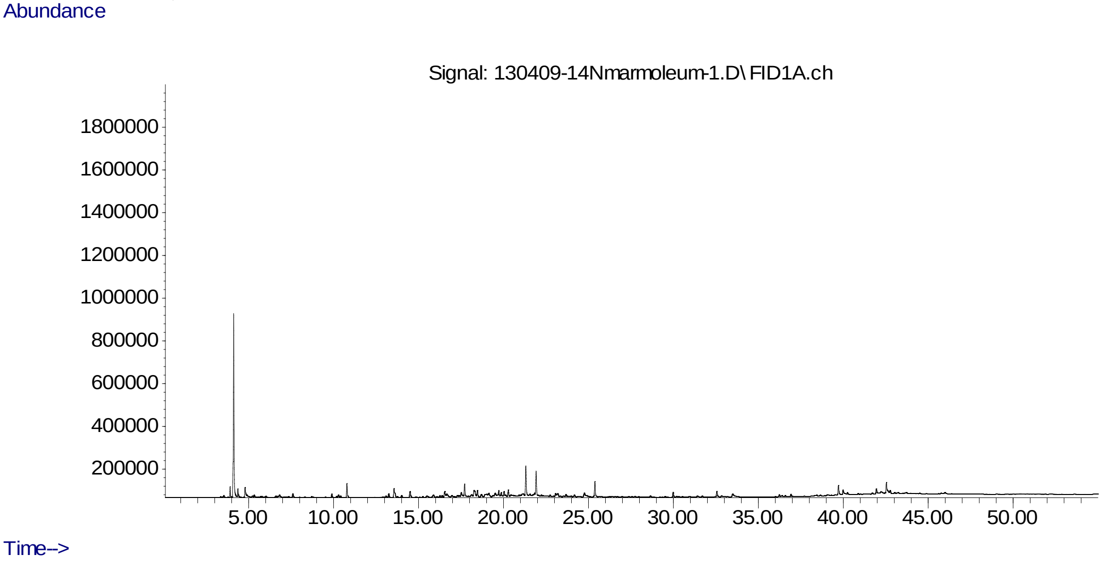
Gas chromatograms

Sample: **Marmoleum Real**, after 28 days (sampled volume: 8 litres):



The compound with the retention time 4.2 min is a contamination from the analysis system.

Sample: Empty chamber (sampled volume: 8 litres):



The background of TVOC in the empty chamber was a little too high (just above 20 µg/m^3).
The same compounds were seen in the sampled air from the sample.