

Forbo Flooring AB  
Robert Jürke  
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## Emission measurement according to M1

(3 appendices)

### Assignment

At the request of Forbo Flooring AB an emission measurement regarding VOC according to “M1 Emission Classification of Building Materials: Protocol for Chemical and Sensory Testing of Building Materials”, ver 8.4.2014, has been carried out.

The measurements are made 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

Product type:	Flooring
Product name:	<b>Flotex Tiles</b>
Batch No:	1213/50
Manufacturing date:	2014-03-12
Packaging:	Twelve tiles, 0.50 x 0.50 m, wrapped in plastic foil
Arrived at SP:	2014-04-09
Test specimen preparation:	Chemical testing: Two pieces were used. They were placed back-to-back and edges and part of front sides were sealed with aluminium tape. Total surface area = 0.40 m <sup>2</sup> .  Sensory testing: Three pieces were used. They were placed back-to-back and edges and part of front sides were sealed with aluminium tape. Total surface area = 0.65 m <sup>2</sup> .
Deviation from protocol:	No deviations
Test period started, date:	2014-04-30
Conditions during ageing:	23 ± 2 °C, 50 ± 5 % RH
Emission samplings, date:	2014-05-28

### Methods

The specimens were conditioned outside the testing chambers in a controlled climate conditions of 23 ± 2 °C and 50 ± 5 % RH. The specimens were placed in the chambers two days before the measurements.

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**Chamber conditions of the test of chemical emissions:**

Test chamber volume:	1.0 m <sup>3</sup> , stainless steel
Temperature:	23 ± 1 °C
Relative Humidity:	50 ± 3 % RH
Air exchange rate:	0.5 h <sup>-1</sup>
Air velocity at specimen surface:	0.1 – 0.3 m/s
Area of sample:	0.4 m <sup>2</sup>
Area specific air flow rate:	1.2 m <sup>3</sup> /m <sup>2</sup> h

**Chamber conditions of the test of sensory acceptability:**

Test chamber volume:	1.0 m <sup>3</sup> , stainless steel
Temperature:	23 ± 1 °C
Relative Humidity:	50 ± 3 % RH
Supply air flow rate:	0.9 l/s = 3.24 m <sup>3</sup> /h
Area of sample:	0.65 m <sup>2</sup>

**Emission sampling and analytical methods:**

Test	Sampling method	Adsorbent	Sampling volume (litre)	Analysis method / Quantification	Detection limit
VOC	SP 1314 <sup>1</sup>	Tenax TA	3 - 8	SP 0601 <sup>2</sup> / FID quantification	1 µg/m <sup>3</sup>
Formaldehyde	SP 1314 <sup>1</sup>	DNPH	50, 140	SP 2303 <sup>3</sup> / HPLC-UV	0.03 µg/sampler
Ammonia	SP 1314 <sup>1</sup>	Silica gel	190, 290	Liquid chromatograph with conductivity detector <sup>4</sup>	0.9 µg/sampler
Sensory evaluation	Untrained panel of min 15 persons	--	--	--	--

<sup>1)</sup> In accordance with ISO 16000-9:2006, accredited method.

<sup>2)</sup> In accordance with ISO 16000-6:2011 and M1 protocol, accredited method.

<sup>3)</sup> In accordance with ISO 16000-3:2001, accredited method.

<sup>4)</sup> 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 16000-6:2011 (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), 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. 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<sup>3</sup> and above. The compound specific response factors were calculated.

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 model room and as area specific emission rates:

A model room has a volume of 30 m<sup>3</sup> and an air change rate of 0.5 changes per hour. The concentration of VOC in the model room can be calculated according to this equation:

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

Conc = concentration of a VOC in the model room, in µg/m<sup>3</sup>  
 SER<sub>a</sub> = area specific emission rate, in µg/m<sup>2</sup>h  
 A = area of sample, in m<sup>2</sup> (12 m<sup>2</sup> for flooring)  
 n = air exchange rate, in changes per hour  
 V = volume of the model room, in m<sup>3</sup>

Results of the chemical testing of the sample of **Flotex Tiles** after 28 days:

Compound	Concentration in model room mg/m <sup>3</sup>	Emission rate mg/m <sup>2</sup> h	Criteria M1 mg/m <sup>2</sup> h
TVOC	0.045	<b>0.056</b>	< 0.2
Carcinogens	< 0.001	< <b>0.001</b>	< 0.005
Formaldehyde	< 0.002	< <b>0.002</b>	< 0.05
Ammonia	0.005	<b>0.006</b>	< 0.03

Test report from Sahlgrenska Universitetssjukhuset: test report 2014:24 dated 2014-06-24.

See appendix 1 for gas chromatogram from the VOC determination.

Results of the sensory evaluation of the sample of **Flotex Tiles** after 28 days:

Evaluator	Sensory evaluation	Criteria M1
1	0.25	$\geq + 0.0$
2	-0.50	
3	0.50	
4	0.25	
5	-0.05	
6	0.50	
7	-0.15	
8	-0.30	
9	0.20	
10	0.20	
11	-0.25	
12	-0.10	
13	0.50	
14	-0.40	
15	0.80	
Arithmetic mean of acceptability:	<b>0.1</b>	

Standard deviation: 0.38

90 % Confidence interval of arithmetic mean: 0.17

The empty sensory test chamber acceptability was determined 2014-05-26. The mean acceptability vote of the empty chamber was  $> 0.8$ .

### Interpretation of the results

The tested product **Flotex Tiles** complies with all the requirements of M1 for the tested parameters.

### Detailed results

Detailed results (emission rates) of the chemical testing after 28 days:

Sample	TVOC (mg/m <sup>2</sup> h) as toluene equivalents between C <sub>6</sub> -C <sub>16</sub>	Formaldehyde (mg/m <sup>2</sup> h)	Ammonia (mg/m <sup>2</sup> h)	Carcinogens (mg/m <sup>2</sup> h) between C <sub>6</sub> -C <sub>16</sub>
1	0.061	< 0.002	0.008	< 0.002
2	0.058	< 0.002	< 0.004	< 0.002
3	0.047	--	--	< 0.002

Single VOCs above 0.005 mg/m<sup>3</sup> in the model room (as toluene equivalents):

Single VOCs	Retention time (min)	CAS number	Emission rate (mg/m <sup>3</sup> )		
			Sample 1	Sample 2	Sample 3
<b>Single VOCs C<sub>6</sub>-C<sub>16</sub>:</b>	5.5 – 36.8				
2-Ethylhexanol	19.2	104-76-7	0.005	0.006	0.007
Probably: 1-Nonanol	22.9	143-08-08	0.010	0.010	0.008
Probably: 6-methyl-1-Octanol	23.3	110453-78-6	0.006	0.006	0.005
Ethanol, 2-(2-butoxyethoxy)-	24.9	112-34-5	0.026	0.025	0.019
		TVOC:	0.049	0.047	0.038
<b>Single VOC outside C<sub>6</sub> – C<sub>16</sub>:</b>					
VVOC (< C <sub>6</sub> ) <sup>5</sup>	4.5 – 5.5				
No single VVOC detected	--	--	--	--	--
SVOC (C <sub>16</sub> – C <sub>22</sub> ) <sup>6</sup>	36.8 - 42.0				
No single SVOC detected	--	--	--	--	--

<sup>5)</sup> VVOC = very volatile organic compounds, as defined in ISO 16000-6 (not accredited)

<sup>6)</sup> 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<sup>3</sup>.

### Measurements uncertainty

SER<sub>TVOC</sub>: ± 15 %, SER<sub>Formaldehyde</sub>: ± 30 %, SER<sub>NH<sub>3</sub></sub>: ± 14 %

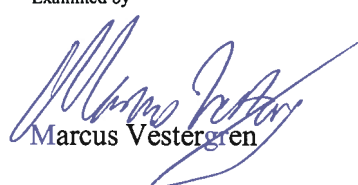
### SP Technical Research Institute of Sweden SP Chemistry, Materials and Surfaces - Chemistry

Performed by



Maria Rådemar

Examined by



Marcus Vestergren

### Appendices

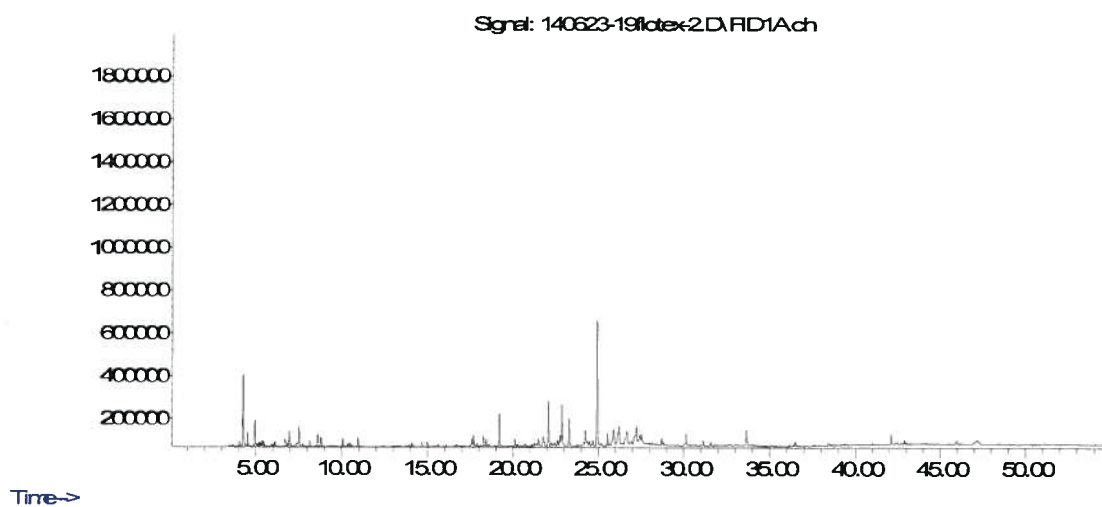
1. Gas Chromatogram
2. Photo of test specimen
3. Sampling report

## Appendix 1

### Gas chromatogram

Sample: **Flotex Tiles**, after 28 days (sampled volume: 7 litres):

Abundance

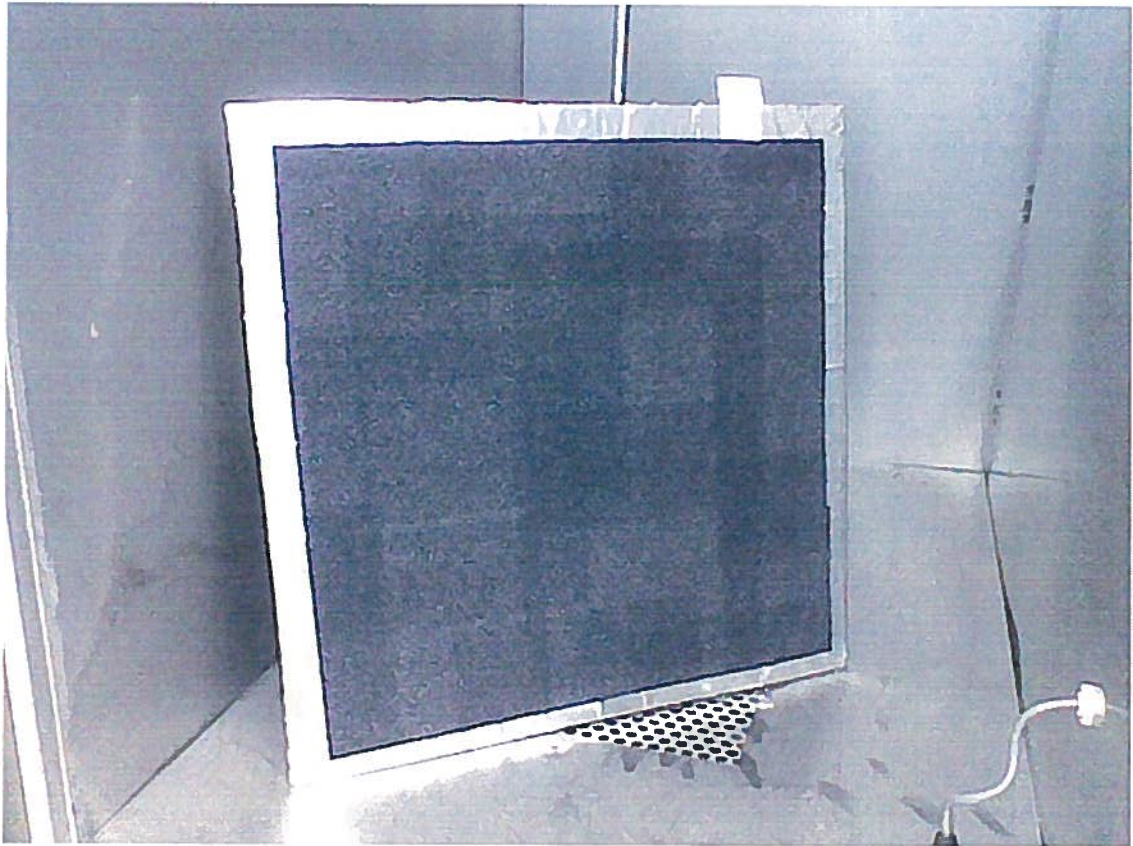


TVOC between C<sub>6</sub> and C<sub>16</sub>, means compounds eluting between 5.5 and 36.8 minutes.

The compound with retention time 4.3 min is a contamination from the analysis system.

Appendix 2

**Photo of test specimen**



Appendix 3

**Sampling Report**

<b>Sampler (Name, Company, contact info)</b> Forbo Flooring AB		<b>Manufacturer of the product</b> Forbo Flooring / Ripley UK	
<b>Name of product:</b> Folex Tiles		<b>Type of product:</b> Flockad PVC/textilplatta 50x50 cm	
<b>Manufacturing Date</b> 2014-03-12		<b>Batch No</b> 1213/50	
<b>Date of sampling:</b> 2014-04-04		<b>Amount of material sampled:</b> 3 m <sup>2</sup>	
<b>Sample is taken from:</b> Product on line                    - Stack / Storage                    x 1  Miscellaneous -where, specify:		<b>How was the product stored before sampling?</b>  Provmaterial uttaget direkt via inleverans till lager.	
If a sub-sample was collected from a larger material amount, describe how the sub-sample was taken			
<b>Observations and remarks</b>			
<b>Confirmation</b> I hereby confirm that the sample was selected, taken and packed in accordance with M1 testing protocol			
<b>Date</b> 2014-04-07		<b>Signature</b> Robert Jürke	

M1 2014



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## Emission measurement according to M1 (3 appendices)

### Assignment

At the request of Forbo Flooring AB an emission measurement regarding VOC according to “M1 Emission Classification of Building Materials: Protocol for Chemical and Sensory Testing of Building Materials”, ver 8.4.2014, has been carried out.

The measurements are made 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

Product type:	Flooring
Product name:	<b>Flotex Senya</b>
Batch No:	01218/03
Manufacturing date:	2014-03-17
Packaging:	4 m <sup>2</sup> , wrapped in plastic foil
Arrived at SP:	2014-04-09
Test specimen preparation:	<p>Chemical testing: Two pieces of 0.47 x 0.47 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 = 0.40 m<sup>2</sup>.</p> <p>Sensory testing: Two pieces of 0.59 x 0.59 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 = 0.65 m<sup>2</sup>.</p>
Deviation from protocol:	No deviations
Test period started, date:	2014-04-30
Conditions during ageing:	23 ± 2 °C, 50 ± 5 % RH
Emission samplings, date:	2014-05-28

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**Methods**

The specimens were conditioned outside the testing chambers in a controlled climate conditions of  $23 \pm 2$  °C and  $50 \pm 5$  % RH. The specimens were placed in the chambers two days before the measurements.

Chamber conditions of the test of chemical emissions:

Test chamber volume:	1.0 m <sup>3</sup> , stainless steel
Temperature:	23 ± 1 °C
Relative Humidity:	50 ± 3 % RH
Air exchange rate:	0.5 h <sup>-1</sup>
Air velocity at specimen surface:	0.1 – 0.3 m/s
Area of sample:	0.4 m <sup>2</sup>
Area specific air flow rate:	1.2 m <sup>3</sup> /m <sup>2</sup> h

Chamber conditions of the test of sensory acceptability:

Test chamber volume:	1.0 m <sup>3</sup> , stainless steel
Temperature:	23 ± 1 °C
Relative Humidity:	50 ± 3 % RH
Supply air flow rate:	0.9 l/s = 3.24 m <sup>3</sup> /h
Area of sample:	0.65 m <sup>2</sup>

Emission sampling and analytical methods:

Test	Sampling method	Adsorbent	Sampling volume (litre)	Analysis method / Quantification	Detection limit
VOC	SP 1314 <sup>1</sup>	Tenax TA	3 - 7	SP 0601 <sup>2</sup> / FID quantification	1 µg/m <sup>3</sup>
Formaldehyde	SP 1314 <sup>1</sup>	DNPH	30, 100	SP 2303 <sup>3</sup> / HPLC-UV	0.03 µg/sampler
Ammonia	SP 1314 <sup>1</sup>	Silica gel	150, 240	Liquid chromatograph with conductivity detector <sup>4</sup>	0.9 µg/sampler
Sensory evaluation	Untrained panel of min 15 persons	--	--	--	--

<sup>1)</sup> In accordance with ISO 16000-9:2006, accredited method.  
<sup>2)</sup> In accordance with ISO 16000-6:2011 and M1 protocol, accredited method.  
<sup>3)</sup> In accordance with ISO 16000-3:2001, accredited method.  
<sup>4)</sup> 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 16000-6:2011 (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), 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. 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<sup>3</sup> and above. The compound specific response factors were calculated.

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 model room and as area specific emission rates:

A model room has a volume of 30 m<sup>3</sup> and an air change rate of 0.5 changes per hour. The concentration of VOC in the model room can be calculated according to this equation:

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

Conc = concentration of a VOC in the model room, in µg/m<sup>3</sup>  
 SER<sub>a</sub> = area specific emission rate, in µg/m<sup>2</sup>h  
 A = area of sample, in m<sup>2</sup> (12 m<sup>2</sup> for flooring)  
 n = air exchange rate, in changes per hour  
 V = volume of the model room, in m<sup>3</sup>

Results of the chemical testing of the sample of **Flotex Senya** after 28 days:

Compound	Concentration in model room mg/m <sup>3</sup>	Emission rate mg/m <sup>2</sup> h	Criteria M1 mg/m <sup>2</sup> h
TVOC	0.026	<b>0.033</b>	< 0.2
Carcinogens	< 0.001	<b>&lt; 0.001</b>	< 0.005
Formaldehyde	< 0.002	<b>&lt; 0.002</b>	< 0.05
Ammonia	0.016	<b>0.020</b>	< 0.03

Test report from Sahlgrenska Universitetssjukhuset: test report 2014:24 dated 2014-06-24.

See appendix 1 for gas chromatogram from the VOC determination.

Results of the sensory evaluation of the sample of **Flotex Senya** after 28 days:

Evaluator	Sensory evaluation	Criteria M1
1	0.50	$\geq +0.0$
2	0.60	
3	0.75	
4	0.45	
5	-0.25	
6	0.20	
7	0.15	
8	0.80	
9	-0.30	
10	0.15	
11	0.20	
12	-0.05	
13	0.10	
14	-0.50	
15	0.90	
Arithmetic mean of acceptability:	<b>0.2</b>	

Standard deviation: 0.42

90 % Confidence interval of arithmetic mean: 0.19

The empty sensory test chamber acceptability was determined 2014-05-26. The mean acceptability vote of the empty chamber was  $> 0.8$ .

### Interpretation of the results

The tested product **Flotex Senya** complies with all the requirements of M1 for the tested parameters.

### Detailed results

Detailed results (emiision rates) of the chemical testing after 28 days:

Sample	TVOC (mg/m <sup>2</sup> h) as toluene equivalents between C <sub>6</sub> -C <sub>16</sub>	Formaldehyde (mg/m <sup>2</sup> h)	Ammonia (mg/m <sup>2</sup> h)	Carcinogens (mg/m <sup>2</sup> h) between C <sub>6</sub> -C <sub>16</sub>
1	0.034	< 0.002	0.019	< 0.002
2	0.032	< 0.002	0.020	< 0.002
3	0.032	--	--	< 0.002

Single VOCs above 0.005 mg/m<sup>3</sup> in the model room (as toluene equivalents):

Single VOCs	Retention time (min)	CAS number	Emission rate (mg/m <sup>3</sup> )		
			Sample 1	Sample 2	Sample 3
<b>Single VOCs C<sub>6</sub>-C<sub>16</sub>:</b>	5.5 – 36.8				
Hexane, 3-methyl-	6.9	589-34-4	0.007	0.006	0.006
Heptane	7.5	142-82-5	0.014	0.014	0.012
Cyclohexane, methyl-	8.6	108-87-2	0.007	0.006	0.007
		TVOC:	0.027	0.026	0.025
<b>Single VOC outside C<sub>6</sub> – C<sub>16</sub>:</b>					
VVOC (< C <sub>6</sub> ) <sup>5</sup>	4.5 – 5.5				
No single VVOC detected	--	--	--	--	--
SVOC (C <sub>16</sub> – C <sub>22</sub> ) <sup>6</sup>	36.8 - 42.0				
No single SVOC detected	--	--	--	--	--

<sup>5)</sup> VVOC = very volatile organic compounds, as defined in ISO 16000-6 (not accredited)

<sup>6)</sup> 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<sup>3</sup>.

### Measurements uncertainty

SER<sub>TVOC</sub>: ± 15 %, SER<sub>Formaldehyde</sub>: ± 30 %, SER<sub>NH<sub>3</sub></sub>: ± 14 %

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

Performed by



Maria Rådemar

Examined by



Marcus Vestergren

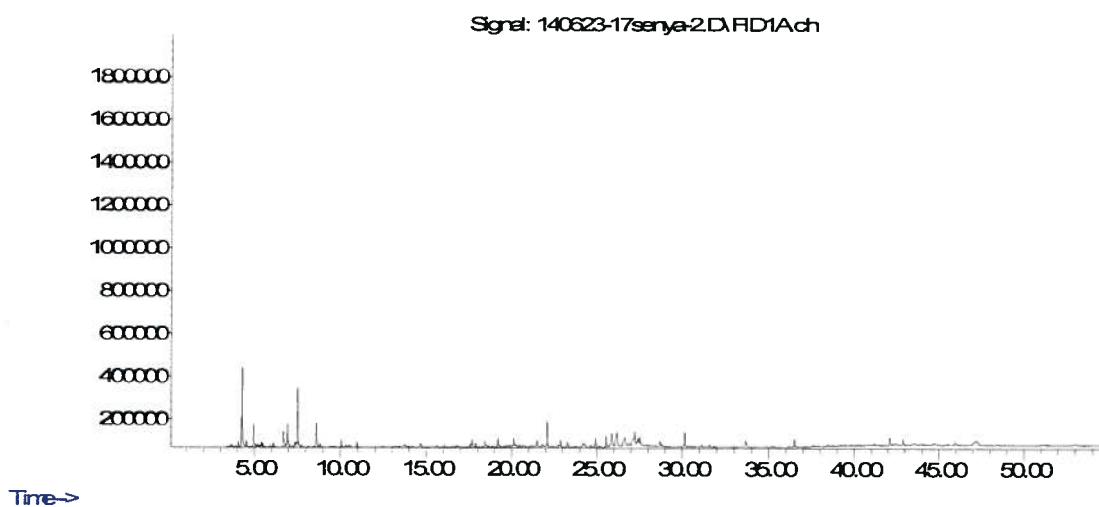
### Appendices

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

Appendix 1

**Gas chromatogram**

Sample: **Flotex Senya**, after 28 days (sampled volume: 7 litres):  
Abundance

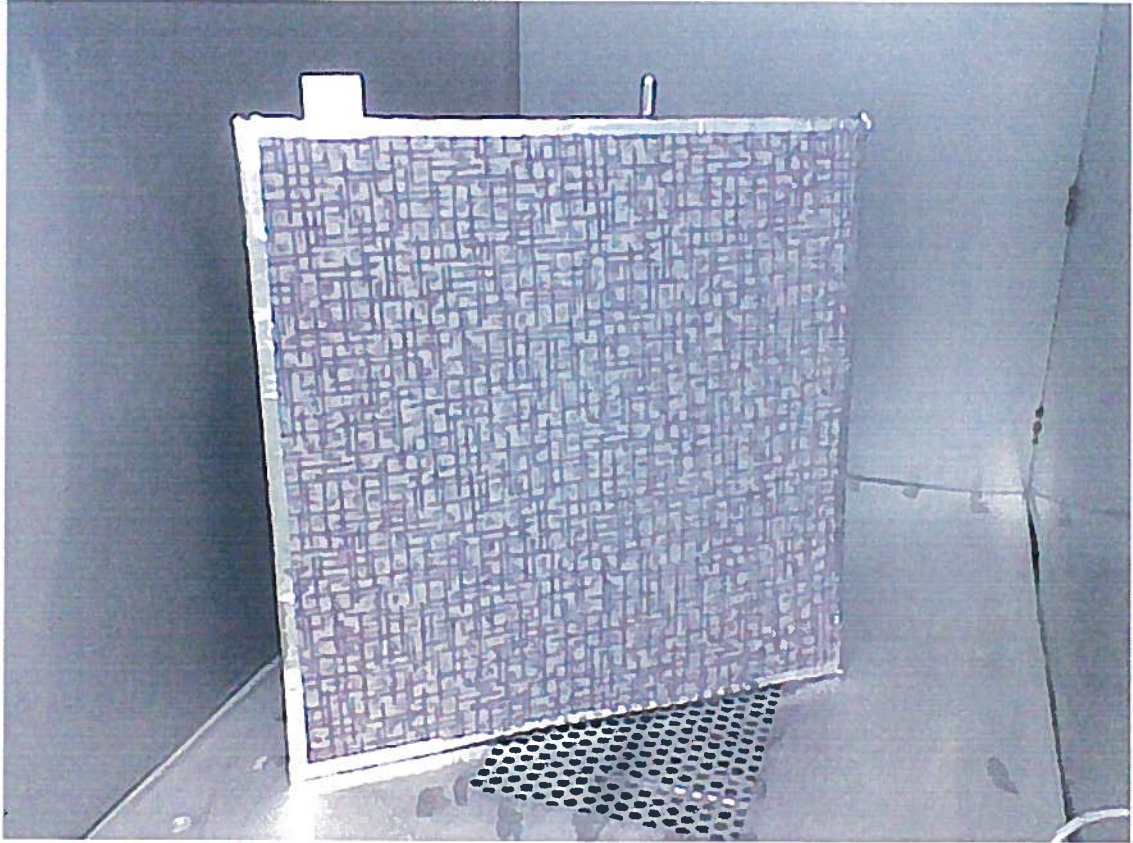


TVOC between C<sub>6</sub> and C<sub>16</sub>, means compounds eluting between 5.5 and 36.8 minutes.

The compound with retention time 4.3 min is a contamination from the analysis system.

Appendix 2

**Photo of test specimen**



Appendix 3

**Sampling Report**

<b>Sampler (Name, Company, contact info)</b>		<b>Manufacturer of the product</b>	
Forbo Flooring AB		Forbo Flooring / Ripley UK.	
<b>Name of product</b>		<b>Type of product</b>	
Flotex Senya		Flockad pvc/textilmatta	
<b>Manufacturing Date</b>		<b>Batch No</b>	
2014-03-17		01218/03	
<b>Date of sampling</b>		<b>Amount of material sampled</b>	
2014-04-04		4 m2	
<b>Sample is taken from:</b>		<b>How was the product stored before sampling?</b>	
Production line <input type="checkbox"/> L		Provmaterial uttaget direkt vid inleverans till lager.	
Stock / Storage <input checked="" type="checkbox"/> X			
Miscellaneous <input type="checkbox"/> I -where, specify:			
If a sub-sample was collected from a larger material amount, describe how the sub sample was taken			
Observations and remarks			
<b>Confirmation</b> I hereby confirm that the sample was selected, taken and packed in accordance with ML testing protocol			
<b>Date</b> 2014-04-04 2014-04-07		<b>Signature</b> Robert Jürke Robert Jürke	

ML 2014