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Emission measurements after 28 days

(2 appendices)

Object

Five samples were delivered to RISE from the customer.

Product name:	Polynum Reflective Insulation
Manufacturing date:	2020-03-23--24
Size of sample:	each sample ca 0.5 x 0.5 m wrapped in plastic foil
Date of arrival to RISE:	2020-05-25
Date of analysis:	week 23 – 34, 2020

Assignment

Emission measurement according to ISO 16000-9:2006 (Indoor air – Part 9: Determination of the emission of volatile organic compounds from building products and furnishing – Emission test chamber method), after 28 days regarding volatile organic compounds (VOC and VVOC/SVOC), carcinogenic substances (VOC-substances, EU Regulation No 1272/2008 Annex VI, cat 1A and 1B), formaldehyde and acetaldehyde (ISO 16000-3:2011). Evaluation according to EN 16516:2017 (EU-LCI values).

Method

Five samples consisting of bubble plastic and aluminium foil in different compositions. The two compositions selected to test were the sample of **bubble plastic – aluminium foil – bubble plastic** and the one with **aluminium foil in four layers and polyester in three layers**. The three samples not tested were one of bubble plastic – aluminium foil, one of aluminium foil – bubble plastic – aluminium foil and one of aluminium foil – large bubble plastic – aluminium foil. These three samples were considered to emit the same or less than the sample of bubble plastic – aluminium foil – bubble plastic.

The tests were started 2020-06-05. A specimen of 20 x 20 cm was cut out of each sample. The specimens were placed in a room with controlled climate conditions of 23 ± 2 °C and 50 ± 5 % RH. The test specimens were placed into the chambers three days prior to air samplings. Air samplings after 28 days of conditioning were carried out on 2020-07-03.

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Test conditions in the chambers:

Chamber volume:	0.03 m ³
Temperature:	23 ± 0.5 °C
Relative humidity:	50 ± 5 % RH
Surface area of test specimen:	0.040 m ²
Air exchange rate:	0.68 h ⁻¹
Area specific air flow rate:	0.53 m ³ /m ² h.
Air velocity at specimen surface:	0.1 – 0.3 m/s

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 capillary column used is coated with 5% phenyl/ 95 % methylpolysiloxane. The FID signals are used for compound quantification. The total volatile organic compounds (TVOC) means compounds eluting between and including n-hexane to hexadecane, having boiling points in the range of about 70-260 °C. Minimum duplicate air samples were taken and the results are mean values. Sampled volumes are 2 to 6 L.

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), 1 µg/m³ and above.

The samplings of aldehydes were 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). This means analysis on a liquid chromatograph with absorbance detector. Duplicate air samples were taken and the results are mean values. Sampled volumes were 20 L.

Results

The results relate only to the items tested. The results in Table 1 and 2 are expressed as area specific emission rates and as concentrations in a reference room (according to EN 16516:2017). The reference 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 m², floor area is 12 m², small area, like a door, is 1.6 m² and very small area, like sealant, is 0.2 m². **Floor area** is used for the calculation of the concentrations.

Calculation of the concentration from the emission rate:

$$C = \frac{E_a \times A}{n \times V}$$

C = concentration of VOC in the reference room, in µg/m³
E_a = area specific emission rate, in µg/m²h
A = surface area of product in reference room, in m²
n = air exchange rate, in changes per hour, here 0.5 h⁻¹
V = volume of the reference room, in m³, here 30 m³

Table 1.

 Emission results of **Polynum Reflective Insulation, bubble plastic – aluminium foil – bubble plastic**, after 28 days

Volatile organic compounds	CAS number	Retention time (min)	ID ¹	Emission rate (µg/m ² h)	Concentration in reference room (µg/m ³)	LCI _i (µg/m ³)	R _i (c _i /LCI _i)
TVOC (C₆ – C₁₆)	--	6.5 – 38	B	< 10	< 10	--	--
Volatile Carcinogens²		6.5 – 38					
No substances detected	--	--	B	< 1	< 1	--	--
VOC with LCI³		6.5 – 38					
No substances detected	--	--	A	< 2	< 5	--	--
∑ VOC with LCI	--	--	A	< 2	< 5	--	--
VOC without LCI⁴		6.5 – 38					
No substances detected	--	--	B	< 2	< 5	--	--
∑ VOC without LCI	--	--	B	< 2	< 5	--	--
SVOC (C₁₆ – C₂₂)⁵		38 - 51					
No substances detected	--	--	B	< 2	< 5	--	--
∑ SVOC	--	--	B	< 2	< 5	--	--
VVOC (< C₆)⁶		5.4 – 6.5					
Formaldehyde ⁷	50-00-0	--	A	n.d.	< 5	100	--
Acetaldehyde ⁷	75-07-0	--	A	n.d.	< 5	1 200	--
∑ VVOC	--	--	A	< 2	< 5	--	--
R = ∑ C_i / LCI_i⁸	--	--	--	--	--	--	< 0.01

¹) ID: A = quantified compound specific, B = quantified as toluene-equivalent

²) Volatile carcinogens = VOCs according to EU Regulation No 1272/2008 Annex VI, cat 1A and 1B

³) VOC with LCI = identified VOC-compound with LCI-value according to EU-LCI, Dec 2019

⁴) VOC without LCI = VOC-compound without LCI-value or not identified.

⁵) SVOC = semi-volatile organic compounds, as defined in ISO 16000-6 (not part of accreditation)

⁶) VVOC = very volatile organic compounds, as defined in ISO 16000-6 (not part of accreditation)

⁷) VVOC-aldehydes measured with DNPH samplers (ISO 16000-3)

⁸) All VVOC, VOC, SVOC and carcinogens with LCI

n.d. = not detected (detection limit is approx 1 µg/m²h)

Table 2.

Emission results of **Polynum Reflective Insulation, aluminium foil in four layers and polyester in three layers**, after 28 days

Volatile organic compounds	CAS number	Retention time (min)	ID ¹	Emission rate ($\mu\text{g}/\text{m}^2\text{h}$)	Concentration in reference room ($\mu\text{g}/\text{m}^3$)	LCI _i ($\mu\text{g}/\text{m}^3$)	R _i (c_i/LCI_i)
TVOC (C ₆ – C ₁₆)	--	6.5 – 38	B	10	< 10	--	--
Volatile Carcinogens ²		6.5 – 38					
Trichloroethylene	79-01-6	9.0	A	11	8	--	--
VOC with LCI ³		6.5 – 38					
Toluene	108-88-3	11.2	A	4	< 5	2900	--
Tetrachloroethylene	127-18-4	12.7	A	3	< 5	80	--
2,2,4-Trimethyl-1,3-pentenediol monoisobutyrate	25265-77-4	32.1+32.6	A	16	13	850	0.015
Σ VOC with LCI	--	--	A	23	13	--	--
VOC without LCI ⁴		6.5 – 38					
No substances detected	--	--	B	< 2	< 5	--	--
Σ VOC without LCI	--	--	B	< 2	< 5	--	--
SVOC (C ₁₆ – C ₂₂) ⁵		38 - 51					
No substances detected	--	--	B	< 2	< 5	--	--
Σ SVOC	--	--	B	< 2	< 5	--	--
VVOC (< C ₆) ⁶		5.4 – 6.5					
Formaldehyde ⁷	50-00-0	--	A	n.d.	< 5	100	--
Acetaldehyde ⁷	75-07-0	--	A	n.d.	< 5	1 200	--
Σ VVOC	--	--	A	< 2	< 5	--	--
$R = \Sigma C_i / \text{LCI}_i$ ⁸	--	--	--	--	--	--	0.015

Only VOC-compounds with an emission rate higher than 2 $\mu\text{g}/\text{m}^2\text{h}$ are listed in the tables, carcinogenic compounds $\geq 1 \mu\text{g}/\text{m}^2\text{h}$. Only the compounds with a concentration in the reference room $> 5 \mu\text{g}/\text{m}^3$ are evaluated based on LCI (= lowest concentration of interest). TVOC is the sum of all individual substances with concentrations $\geq 5 \mu\text{g}/\text{m}^3$ (in toluene equivalents).

Quantification limit for TVOC is 10 $\mu\text{g}/\text{m}^2\text{h}$. Measurement uncertainty for VOC is 15 % (rel) and for formaldehyde 30 % (rel). Background of TVOC in the empty chamber was below 10 $\mu\text{g}/\text{m}^3$ and is subtracted.

See Appendix 1 for a gas chromatograms (FID spectra) and Appendix 2 for photos of the test specimens.

Summary of the test results

The test results are summarized in Table 3 and 4.

Table 3.

Summary of the emission results after 28 days of **Polynum Reflective Insulation, bubble plastic – aluminium foil – bubble plastic**

Compounds	Emission rate ($\mu\text{g}/\text{m}^2\text{h}$)	Concentration in reference room ($\mu\text{g}/\text{m}^3$)
TVOC	< 10	< 10
Σ Carcinogenic VOCs	< 1	< 1
Σ VOC with LCI	< 2	< 5
Σ VOC without LCI	< 2	< 5
Σ VVOC	< 2	< 5
Formaldehyde	< 2	< 5
Σ SVOC	< 2	< 5
$R = \Sigma C_i / LCI_i$	< 0.01	

Table 4.

Summary of the emission results after 28 days of **Polynum Reflective Insulation, aluminium foil in four layers and polyester in three layers**

Compounds	Emission rate ($\mu\text{g}/\text{m}^2\text{h}$)	Concentration in reference room ($\mu\text{g}/\text{m}^3$)
TVOC	10	< 10
Σ Carcinogenic VOCs	11	8
Σ VOC with LCI	23	13
Σ VOC without LCI	< 2	< 5
Σ VVOC	< 2	< 5
Formaldehyde	< 2	< 5
Σ SVOC	< 2	< 5
$R = \Sigma C_i / LCI_i$	0.02	

Evaluation of the test results

The emission results can be compared to different Emission Labelling Systems.

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.

Byggvarubedömningen has criteria regarding Emissions to indoor environment. The emissions are to be measured according to a standard method such as ISO 16000-9 after 28 days regarding VOC. The requirements for the *Recommended class* is that the requirements to one of the following systems are being met: Emission EC1, Emission EC1^{PLUS}, Blue Angel, M1 (RTS) or GUT. The results of the tested samples are compared to M1.

Table 5.

The test results of **Polynum Reflective Insulation, bubble plastic – aluminium foil – bubble plastic** are compared to the relevant requirements in M1

Compounds	Requirement M1 (mg/m ² h)	Test Results (mg/m ² h)	Pass / Fail
TVOC	< 0.2	< 0.010	PASS
Formaldehyde	< 0.05	< 0.002	PASS
CMR 1A+1B	< 0.001	< 0.001	PASS
Single VOC (µg/m ³)	≤ EU-LCI	≤ EU-LCI	PASS
Ammonia	< 0.03	not measured	--
Odour	≥ 0.0	not measured	--

Table 6.

The test results of **Polynum Reflective Insulation, aluminium foil in four layers and polyester in three layers** are compared to the relevant requirements in M1

Compounds	Requirement M1 (mg/m ² h)	Test Results (mg/m ² h)	Pass / Fail
TVOC	< 0.2	0.010	PASS
Formaldehyde	< 0.05	< 0.002	PASS
CMR 1A+1B	< 0.001	0.011	FAIL
Single VOC (µg/m ³)	≤ EU-LCI	≤ EU-LCI	PASS
Ammonia	< 0.03	not measured	--
Odour	≥ 0.0	not measured	--

Results of evaluation:

The test results of **Polynum Reflective Insulation, bubble plastic – aluminium foil – bubble plastic** are in compliance with the requirements of M1. The other three compositions of bubble plastic and aluminium foil are also in compliance with the requirements of M1.

These four samples meet the requirements of Byggvarubedömningen of the *Recommended class* regarding Emissions of VOC to the indoor environment.

The test results of **Polynum Reflective Insulation, aluminium foil in four layers and polyester in three layers** fails in the requirement of carcinogenic VOCs and is not in compliance with all the requirements of M1. This sample does not meet the requirements of Byggsvarubedömningen of the *Recommended class* or *Accepted class* regarding Emissions of VOC to the indoor environment.

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Appendices

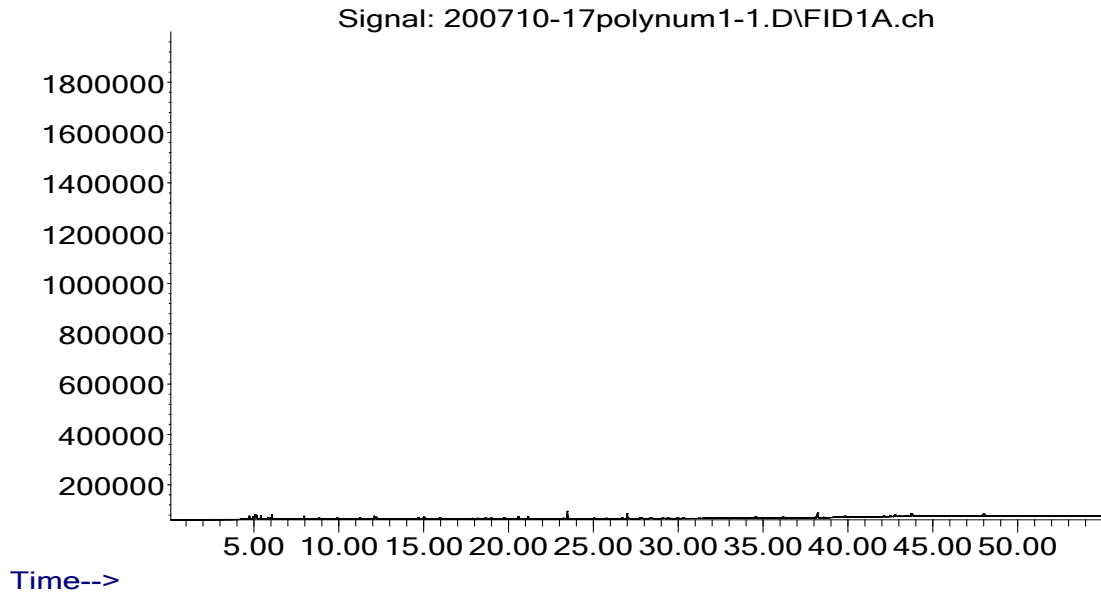
1. Gas Chromatograms
2. Photos of the test specimen

Appendix 1

Gas chromatograms

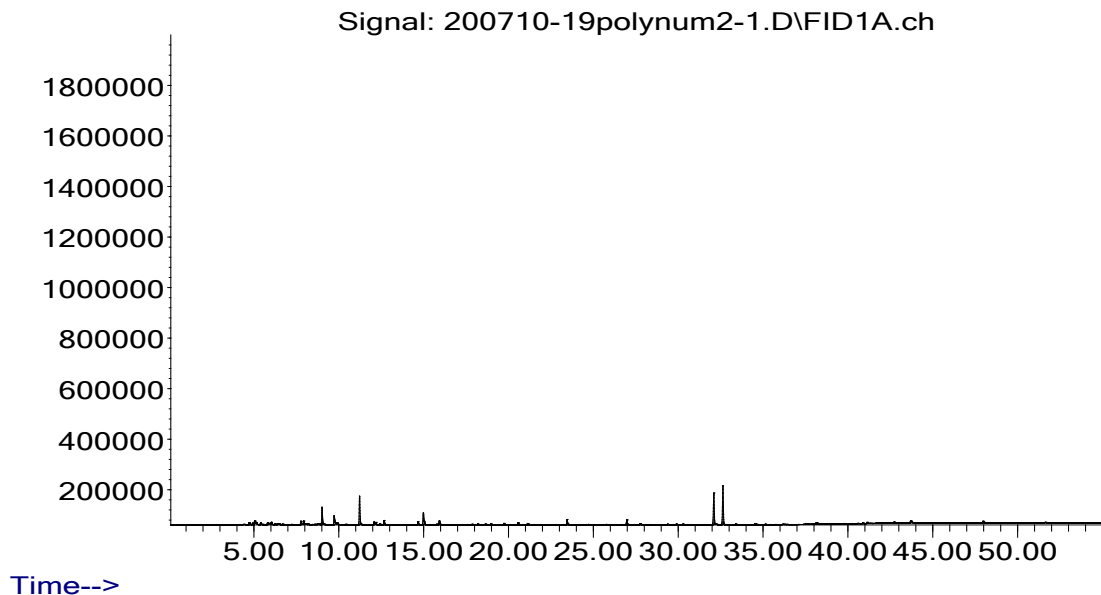
ThermoReflekt, bubble plastic – aluminium foil – bubble plastic, after 28 days:

Abundance



ThermoReflekt, aluminium foil in four layers and polyester in three layers, after 28 days:

Abundance



TVOC between C₆ and C₁₆, means compounds eluting between 6.6 and 38 minutes.

Appendix 2

Photos of the test specimen**Polynum Reflective Insulation, bubble plastic – aluminium foil – bubble plastic****Polynum Reflective Insulation, aluminium foil in four layers and polyester in three layers**