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ilac-MRA DANAK TEST Reg.nr. 522

Kinnarps AB
PO Box 3060
521 88 Kinnarp
SWEDEN

Eurofins Product Testing A/S
Smedeskovvej 38
8464 Galten
Denmark

CustomerSupport@eurofins.com
www.eurofins.com/VOC-testing

VOC EMISSION TEST REPORT
Indoor Air Comfort GOLD®

28 June 2018

1 Sample Information

Sample name	Esencia
Batch no.	820 1143 0010
Production date	14/05/2018
Product type	Upholstered office chair
Sample reception	17/05/2018

2 Brief Evaluation of the Results

Regulation or protocol	Conclusion	Version of regulation or protocol
Indoor Air Comfort GOLD®	Pass	Indoor Air Comfort GOLD 6.0 of February 2017
M1	Pass ¤ #	M1 Protocol of November 2017
DE UZ 117	Pass ¤	DE UZ 117 for "Low-Emission Upholstered Furniture" (version January 2018)
RAL GZ 430	Pass ¤	RAL GZ 430 for "General Quality and Testing Regulations for Furniture" (version January 2016)

Full details based on the testing and direct comparison with limit values are available in the following pages

¤ The performed test does not include evaluation on odour characteristics; as a result the evaluation has not taken the odour characteristics into account.

The performed test does not include evaluation on ammonia emissions; as a result the evaluation has not taken the odour characteristics into account.

Thomas Bjerring
Consultant

Rasmus Stengaard Christensen
Analytical Service Manager, MSc in Chemistry

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3 Applied Test Methods

3.1 General Test References

Regulation, protocol or standard	Version	Reporting limit VOC [µg/m³]	Calculation of TVOC	Combined uncertainty¤ [RSD(%)]
ISO 16000 -3 -6 -9 -11	2006-2011 depending on part	2	Toluene equivalents	22%
ASTM D5116-10	2010	-	-	-
Specifications Indoor Air Comfort Gold	6.0 of February 2017	5	Toluene equivalents	22%
M1	M1 Protocol of November 2017	5	Toluene equivalents	22%
DE UZ 117	January 2018	5	Compound Specific	22%
RAL GZ 430	January 2016	2	Compound Specific	22%

3.2 Specific Laboratory Sampling and Analyses

Procedure	External Method	Internal SOP	Quantification limit / sampling volume	Analytical principle	Uncertainty¤ [RSD(%)]
Sample preparation	ISO 16000-11:2006	71M549810	-	-	-
Emission chamber testing	ISO 16000-9:2006	71M549811	-	Chamber and air control	-
Sampling of VOC	ISO 16000-6:2011	71M549812	5 L	Tenax TA	-
Analysis of VOC	ISO 16000-6:2011	71M542808B	1 µg/m³	ATD-GC/MS	10%
Sampling of aldehydes	ISO 16000-3:2011	71M549812	35 L	DNPH	-
Analysis of aldehydes	ISO 16000-3:2011	71M548400	3-6 µg/m³	HPLC-UV	10%
Sampling of phthalates	ISO 16200-1, MEL-09, OSHA CSI	71M549812	60 L	XAD-2	-
Analysis of phthalates*	CPSC-CH-C1001-09.3 (2010)	71M546060	0.6 µg/m³	GC/MS	10%

4 Test Parameters, Sample Preparation and Deviations

4.1 VOC Emission Chamber Test Parameters

Parameter	Value	Parameter	Value
Chamber volume, V[L]	1000	Preconditioning period	-
Air Change rate, n[h^{-1}]	0.5	Test period	22/05/2018 - 19/06/2018
Relative humidity of supply air, RH [%]	50 ± 3	Area specific ventilation rate, q [m/h or m^3/unit/h]	0.5
Temperature of supply air, T [°C]	23 ± 1	Loading factor [unit/m^3]	1 ** / ***

** The 3 day results have been recalculated to 0.03 unit/m^3 according to the M1 test protocol. As a result the concentrations given in the 3 day screening are the expected concentrations from having 1 specimen in the European Reference Room.
*** The 28 day results have been recalculated to 0.13 unit/m^3 according to the RAL UZ 117 test protocol. As a result the concentrations given in the 28 day screening are the expected concentrations from having 3.75 specimens in the European Reference Room.

4.2 Preparation of the Test Specimen

The sample was inserted directly into the emission chamber. The chair was placed on one side to fit in the chamber, with minimal chamber to sample contact.

4.3 Picture of Sample

4.4 Deviations from Referenced Protocols and Regulations

The performed test does not include evaluation on odour characteristics.
The performed test does not include evaluation on ammonia emissions.
The performed test was not carried out in a 2+ m^3 as specified in the DE UZ 117 protocol.
The performed test was not carried out with an air change rate of 4 m^3/h as specified in the DE UZ 117 protocol.
The packaging of the received sample was not air-tight. Premature degassing or contamination cannot be excluded.

5 Results

5.1 VOC Emission Test Results according to M1 (3 Days)

	CAS No.	Retention time [min]	ID-Cat	Specific Conc. [µg/m³]	Toluene eq. [µg/m³]	Specific SER [µg/(unit·h)]	R_D	R_B
VOC with NIK								
Acetic acid * [a]	64-19-7	1.98	1	0.15	< 2	2.2		
Dimethylformamide *	68-12-2	4.51	1	1.9	0.47	28		
Cyclopentanone *	120-92-3	4.74	1	0.21	0.083	3.2		
Hexanal	66-25-1	4.96	1	0.093	< 2	1.4		
Phenol *	108-95-2	8.41	1	0.080	< 2	1.2		
2,2,4,6,6-Pentamethylheptane *	13475-82-6	8.59	1	0.17	0.20	2.6		
Caprolactam *	105-60-2	11.95	1	0.27	0.10	4.0		
Not identified *		15.19	4	0.077	0.077	1.1		
Saturated aliphatic hydro-carbons higher than C9 *		8.9-13.1	2	1.1	1.1	16		
VOC without NIK								
1,6-Dioxacyclododecane-7,12-dione *	777-95-7	14.94	2	0.20	0.20	3.1		
Sum of VOC without NIK				< 5	< 5	< 80		
VVOC compounds								
None determined								
TVVOC				< 5	< 5	< 80		
SVOC compounds								
Not identified *		15.80	4	0.17	0.17	2.5		
TSVOC				< 5	< 5	< 80		
Carcinogens								
Total carcinogens				< 1	< 1	< 20		
Aldehydes								
Formaldehyde	50-00-0		1	0.36		5.4		
Acetaldehyde	75-07-0		1	< 1		< 4		
Propionaldehyde	123-38-6		1	< 1		< 4		
Butyraldehyde	123-72-8		1	< 1		< 4		
2-butenal	123-73-9		1	< 1		< 6		
Glutaraldehyde	111-30-8		1	< 1		< 6		
R-values							0	0
TVOC				< 5	< 5	< 80		

The results are only valid for the tested sample(s).

5.2 VOC Emission Test Results according to DE UZ 117 / RAL GZ 430 (28 Days)

	CAS No.	Retention time [min]	ID-Cat	Specific Conc. [µg/m³]	Toluene eq. [µg/m³]	Specific SER [µg/(unit·h)]	R_D	R_B
VOC with NIK								
n-Heptane	142-82-5	2.75	1	0.38	0.25	1.5		
Not identified *		8.29	4	0.35	0.36	1.4		
n-Dodecane	112-40-3	11.05	1	0.28	0.49	1.1		
Caprolactam *	105-60-2	11.67	1	1.7	0.66	6.9		
Not identified *		14.06	4	0.33	0.33	1.3		
Butylhydroxytoluene BHT *	128-37-0	14.28	1	0.55	0.71	2.2		
1,6-Dioxacyclododecane-7,12-dione *	777-95-7	14.64	2	1.7	1.6	6.6		
Not identified *		14.89	4	0.63	0.63	2.5		
Not identified *		14.93	4	0.68	0.68	2.7		
Saturated aliphatic hydrocarbons higher than C9 *		8.8-13.3	2	5.3	5.3	21	0.00088	0.00088
VOC without NIK								
None determined								
Sum of VOC without NIK				< 5	< 5	< 20		
VVOC compounds								
None determined								
TVVOC				< 5	< 5	< 20		
SVOC compounds								
None determined								
TSVOC				< 5	< 5	< 20		
Carcinogens								
Total carcinogens				< 1	< 1	< 1		
CMR substances								
Benzene	71-43-2		1	< 1		< 1		
Trichloroethylene	79-01-6		1	< 1		< 1		
Dibutylphthalate (DBP)*	84-74-2		1	< 1		< 1		
Diethylhexylphthalate (DEHP)*	117-81-7		1	< 1		< 1		
Aldehydes								
Formaldehyde	50-00-0		1	0.62		2.5		
Acetaldehyde	75-07-0		1	< 1		<2		
Propionaldehyde	123-38-6		1	< 1		<2		

	CAS No.	Retention time [min]	ID-Cat	Specific Conc. [µg/m³]	Toluene eq. [µg/m³]	Specific SER [µg/(unit·h)]	R_D	R_B
Butyraldehyde	123-72-8		1	< 1		< 2		
2-butenal	123-73-9		1	< 1		< 3		
Glutaraldehyde	111-30-8		1	< 1		< 3		
R-values							0.00088	0.00088
TVOC				5.3	5.3	21		

6 Summary and Evaluation of the Results

6.1 Comparison with Limit Values of Indoor Air Comfort Gold®

	Test after 3 days		Test after 28 days	
	Concentration µg/m³	**Limit Value** µg/m³	**Concentration** µg/m³	**Limit Value** µg/m³
TVOC (EN 16516)	< 5	≤ 1000	5.3	≤ 100
TSVOC	< 5	-	< 5	≤ 50
R_D-value (NIK) (dimensionless)	0	-	0.00088	≤ 1
R_B-value (LCI) (dimensionless)	0	-	0.00088	≤ 1
TVOC without NIK or LCI	< 5	-	< 5	≤ 40
Total carcinogens	< 1	≤ 10	-	-
Any individual carcinogens	-	-	< 1	≤ 1
CMR substances	-	-	< 1	≤ 1
Formaldehyde	0.36	-	0.62	≤ 10
Acetaldehyde	< 1	-	< 3	≤ 200
Pass M1 conclusion	Complies		-	-
Pass DE UZ 117 conclusion	-	-	Complies	

Compliance with the limits alone does not entitle to use the Indoor Air Comfort GOLD label. This requires an application, site inspection, and approval. See www.eurofins.com/iac-procedures.

6.2 Comparison with M1 Limit Values

Parameter	**Conc. In Toluene Eq.** µg/m³	**Limit Value (3 day)** µg/m³
TVOC	< 5	≤ 20
Formaldehyde	0.36	≤ 10
Ammonia	N/A	≤ 10
Total CMR	0.47	≤ 1
Odour (dimensionless)	N/A	≥ 0.0
Single VOCs with EU-LCI	Complies	≤ EU-LCI

6.3 Comparison with Limit Values of Blue Angel (DE UZ 117)

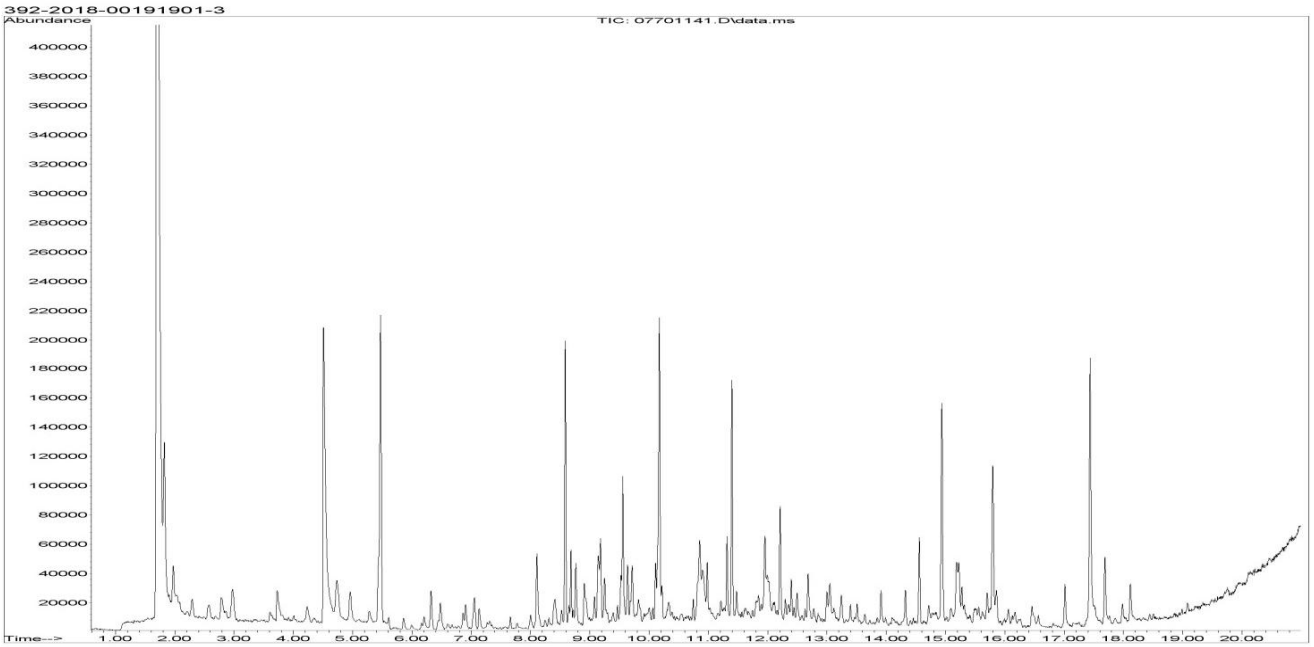
	Test after 3 days		Test after 28 days	
	Concentration µg/m³	**Concentration** µg/m³	**Concentration** µg/m³	**Concentration** µg/m³
TVOC	7.0	-	5.3	≤ 450
TSVOC	< 5	-	< 5	≤ 80
R-value (dimensionless)	0	-	0.00088	≤ 1
TVOC without NIK	< 5	-	< 5	≤ 100
Total carcinogens	< 1	≤ 10	-	-
Total reprotoxic without LCI	7.0	-	< 1	≤ 20 (*total*)
Any individual carcinogens	-	-	< 1	≤ 1
Formaldehyde	-	-	0.62	≤ 60

6.4 Comparison with Limit Values of RAL GZ 430

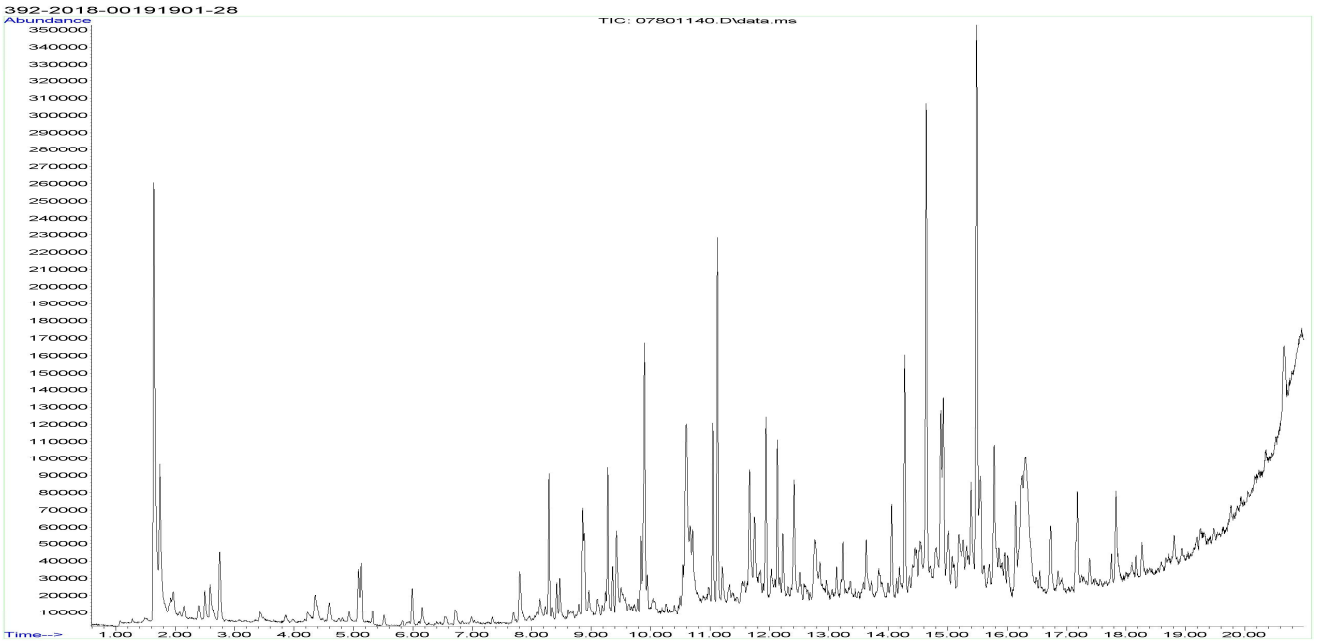
	Test after 3 days		Test after 28 days	
	Concentration mg/m³	**Concentration** mg/m³	**Concentration** mg/m³	**Concentration** mg/m³
TVOC	0.0070	≤ 3	0.0053	≤ 0.4
TSVOC	< 0.005	-	< 0.005	≤ 0.1
R-value (dimensionless)	0	-	0.00088	≤ 1
TVOC without NIK	< 0.005	-	< 0.005	≤ 0.1
Total carcinogens	< 0.001	≤ 0.01	-	-
Any individual carcinogens	-	-	< 0.001	≤ 0.001
Formaldehyde	-	-	0.00062	≤ 0.060

7 Appendices

7.1 Chromatogram of VOC Emissions after 3 Days



7.2 Chromatogram of VOC Emissions after 28 Days



Please consider the different scales.

7.3 Sampling Report

Name of applicant: (name, company, phone):	Daniel Landberg, Kinnarps AB, +46 0706 386452	**Producer** (if different from company's name at place of sampling):	
Production plant, where sampling takes place	Kinnarps AB, Industrigatan 1, SE-521 88 Kinnarp	**Sampler *** (Please mark): (name, company, phone):	Daniel Landberg, Kinnarps AB, +46 0706 386452
Name of the product:	Esencia	**Type of product**	Office work chair
Model / Program / Series:	Esencia office work chair	**Batch N°:**	820 1143 0010
Article N°:	D-1075-DGLM	**Date of batch production:**	2018-05-14
Sample was taken from	X ongoing production ☐ stocks ☐ retained sample	**Date of sampling:** **Time of sampling:**	2018-05-14 11.00
Where had the product been stored prior to sampling? **Place of storage:**	☐ production ☐ store ☐ miscellaneous The sample was taken directly from production line and rapped in plastic bag	**How had the product been stored prior to sampling?** **Packing material:**	☐ open ☐ in the stack ☐ wrapped up
Specifics (possible negative influences by air contamination where sample was taken, by petrol emissions, by solvent emissions from production; any other uncertainties, questions, etc).		no	
Cut edges (identification of cut edges when present and identification of new surfaces and surface to be exposed in the emission test):			
Confirmation Herewith the signer confirms the correctness of the data given above. The sample was selected, drawn and packed personally in accordance with the instructions for the taking of samples.			
Date:	**Signature:** (Stamp)		

7.4 How to Understand the Results

7.4.1 Acronyms Used in the Report

< Means less than

> Means bigger than

* Not a part of our accreditation

¤ Please see section regarding uncertainty in the Appendices.

§ Deviation from method. Please see deviation section

a The method is not optimal for very volatile compounds. For these substances smaller results and a higher measurement uncertainty cannot be ruled out.

B The component originates from the wooden panels and is thus removed.

C The results have been corrected by the emission from wooden panels.

D Very polar organic compounds are not suitable for reliable quantification using tenax TA adsorbent and HP-5 GC column. A high degree of uncertainty must be expected.

E The component may be overestimated due to contribution from the system

SER Specific Emission Rate.

7.4.2 Explanation of ID Category

Categories of Identity:

1: Identified and specifically calibrated

2: Identified by comparison with a mass spectrum obtained from library and supported by other information. Calibrated as toluene equivalent.

3: Identified by comparison with a mass spectrum obtained from a library. Calibrated as toluene equivalent.

4: Not identified, calibrated as toluene equivalent.

7.5 Applied LCI and NIK Values

7.5.1 LCI/NIK Values for Compounds found after 3 Day Measurements

Compound	CAS No.	AgBB 2015 NIK [µg/m³]	Belgian NIK [µg/m³]	EU-LCI [µg/m³]
Acetic acid * [a]	64-19-7	(1250)	(1250)	1200
Dimethylformamide *	68-12-2	(15)	(15)	(reprotoxic)
Cyclopentanone *	120-92-3	(900)	(900)	900
Hexanal	66-25-1	(900)	(900)	900
Phenol *	108-95-2	(10)	(10)	
2,2,4,6,6-Pentamethylheptane *	13475-82-6	(6000)	(6000)	6000
Caprolactam *	105-60-2	(300)	(300)	300
Not identified *				
Saturated aliphatic hydrocarbons higher than C9 *		(6000)	(6000)	6000
Formaldehyde	50-00-0	(100)	(100)	100

7.5.2 LCI/NIK Values for Compounds found after 28 Day Measurements

Compound	CAS No.	AgBB 2015 NIK [µg/m³]	Belgian NIK [µg/m³]
Saturated aliphatic hydrocarbons higher than C9 *		6000	6000
Formaldehyde	50-00-0	100	100

7.6 Description of VOC Emission Test

7.6.1 Test Chamber

The test chamber is made of stainless steel. A multi-step air clean-up is performed before loading the chamber, and a blank check of the empty chamber is performed.
The chamber operation parameters are as described in the test method section. (EN 16516, ISO 16000-9, internal method no.: 71M549811).

7.6.2 Expression of the Test Results

All test results are calculated as specific emission rate, and as extrapolated air concentration in the European Reference Room (EN 16516, AgBB, EMICODE, M1 and Indoor Air Comfort).

7.6.3 Testing of Carcinogenic VOCs

The emission of carcinogens (EU Categories C1A and C1B, as per European law) is tested by drawing sample air from the test chamber outlet through Tenax TA tubes after the specified duration of storage in the ventilated test chamber. Analysis is performed by ATD-GC/MS (automated thermal desorption coupled with gas chromatography and mass spectroscopy using 30 m HP-5 (slightly polar) column with 0.25 mm ID and 0.25 µm film, Agilent) (EN 16516, ISO 16000-6, internal methods no.: 71M549812 / 71M542808B).

All identified carcinogenic VOCs are listed; if a carcinogenic VOC is not listed then it has not been detected. Quantification is performed using the TIC signal and authentic response factors, or the relative response factors relative to toluene for the individual compounds.

This test only covers substances that can be adsorbed on Tenax TA and can be thermally desorbed. If other emissions occur, then these substances cannot be detected (or with limited reliability only).

7.6.4 Testing of VOC, SVOC and VVOC

The emissions of volatile organic compounds are tested by drawing sample air from the test chamber outlet through Tenax TA tubes after the specified duration of storage in the ventilated test chamber. Analysis is performed by ATD-GC/MS using HP-5 column (30 m, 0.25mm ID, 0.25µm film) (EN 16516, ISO 16000-6, internal methods no.: 71M549812 / 71M542808B).

All single substances that are listed with a LCI/NIK value in the latest publications (hereafter referred to as target compounds) are identified if present. All other appearing VOCs are identified as far as possible. Quantification of target compounds is done using the TIC signal and authentic response factors, or the relative response factors relative to toluene. For certain compound groups, which differ significantly in chemistry from toluene, quantification is performed relative to a representative member of the group for more accurate and precise results. This can include quantification of for example glycols and acids. In addition to that, all results are also expressed in toluene equivalents. All non-target compounds, as well as all non-identified substances, are quantified in toluene equivalents.

The results of the individual substances are calculated in three groups depending on their retention time when analyzing using a non-polar column (HP-1):

- Volatile Organic Compounds (VOC) are defined as: All substances eluting between and including n-hexane (n-C6) and n-hexadecane (n-C16)
- Semi-Volatile Organic Compounds (SVOC) are defined as: All substances eluting after n-hexadecane (n-C16) and before and including n-docosane (n-C22)
- Very Volatile Organic Compounds (VVOC) are defined as: All substances eluting before n-hexane (n-C6).

Total Volatile Organic Compounds (TVOC) is calculated by summation of all individual VOCs with a concentration ≥ 5 µg/m³. The TVOC can be expressed either in toluene equivalents as defined in EN 16516 and similar to ISO 16000-6, or as the sum of concentrations using specific or relative response factors. In the case of summation of concentrations using authentic or relative response factors, the toluene equivalent is applied to all non-target and non-identified VOCs before summing up. Compounds regarded as VOC in line with the above definition but elute before n-C6 or after n-C16 on the HP-5 column are treated as VOC, and are thus added to the TVOC.

Total Semi-Volatile Organic Compounds (TSVOC) is calculated by the summation of all individual SVOCs expressed in toluene equivalents with a concentration ≥ 5 µg/m³, as defined in EN 16516. VOCs that are regarded as VOC in line with the above definition, but elute after n-C16 in this test, are not added to the TSVOC.

Total Very Volatile Organic Compounds (TVVOC) is calculated by the summation of all individual VVOCs with a concentration ≥ 5 µg/m³ and expressed in toluene equivalents. VOCs that are regarded as VOC in line with the above definition, but elute before n-C6 in this test, are not added to the TVVOC.

This test only covers substances which can be adsorbed on Tenax TA and can be thermally desorbed. If emissions of substances outside these specifications occur then these substances cannot be detected (or with limited reliability only).

7.6.5 Calculation of R Values with LCI Lists

The concentrations of detected compounds ≥ 5 µg/m³ are divided by their respective LCI/NIK value (if defined in the given publication). The sum of the quotients gives the R value, which can be mathematically expressed:

$$R = \sum_{i}^{n} \left({}^{c_i}/_{NIK_i} + \ldots + {}^{c_n}/_{NIK_n} \right)$$

This R value is calculated, depending on the purpose of this test, for the European LCI list, for the German LCI/NIK list (R_D), and/or for the Belgian LCI list (R_B).

All VOCs without published LCI/NIK value and concentration ≥ 5 µg/m³ are summed up as sum of VOCs without LCI/NIK if required by the standard or protocol.

7.6.6 Testing of Aldehydes

The presence of aldehydes is tested by drawing air samples from the test chamber outlet through DNPH-coated silicagel tubes after the specified duration of storage in the ventilated test chamber. Analysis is performed by solvent desorption and subsequently by HPLC and UV-/diode array detection.

The absence of formaldehyde and other aldehydes is stated if UV detector response at the specific wavelength is lacking at the specific retention time in the chromatogram. Otherwise it is checked whether the reporting limit is exceeded. In this case the identity is finally checked by comparing full scan sample UV spectra with full scan standard UV spectra.

7.6.7 Testing of Phthalates

The presence of phthalates is tested by drawing air samples from the test chamber outlet through tube with XAD-II adsorbent after the specified duration of storage in the ventilated test chamber. Analysis is performed by solvent desorption and subsequently by GC/MS. Analysis of phthalates is not currently covered by the accreditation (Internal methods no.: 71M549812 / 71M546060).

7.7 Quality Assurance

Before loading the test chamber, a blank check of the empty chamber is performed and compliance with background concentrations in accordance with EN 16516 / ISO 16000-9 is determined.

Air sampling at the chamber outlet and subsequent analysis is performed in duplicate. Relative humidity, temperature and air change rate in the chambers is logged every 5 minutes and checked daily. A double determination is performed on random samples at a regular interval and results are registered in a control chart to ensure the uncertainty and reproducibility of the method.

The stability of the analytical system is checked by a general function test of device and column, and by use of control charts for monitoring the response of individual substances prior to each analytical sequence.

7.8 Accreditation

The testing methods described above are accredited on line with EN ISO/IEC 17025 by DANAK (no. 522). This accreditation is valid worldwide due to mutual approvals of the national accreditation bodies (ILAC/IAF, see also www.eurofins.com/galten.aspx#accreditation.

Not all parameters are covered by this accreditation. The accreditation does not cover parameters marked with an asterisk (*), however analysis of these parameters is conducted at the same level of quality as for the accredited parameters.

7.9 Uncertainty of the Test Method

The relative standard deviation of the overall analysis is 22%. The expanded uncertainty Um equals 2 x RSD. For further information please visit www.eurofins.dk/uncertainty.