Association for the Control of Emissions in Products for Flooring Installation, Adhesives and Building Materials (GEV)

GEV – Testing Method

Determination of Volatile Organic Compounds for Classification in the EMICODE system

(Edition: 20.09.2022 – replaces: 02.03.2022)

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1. Abstract

The emissions behaviour of flooring installation products, adhesives, construction products as well as lacquers, finishes and oils for parquet, for mineral floorings and for resilient floorings – in the following called “products” – is determined after a well-defined storage period in a test chamber. Short-term (after 3 days) and long-term (after 28 days) emissions are evaluated. Testing is performed for a number of substances that are recognised or suspected carcinogens (C1A, C1B) and for sum parameters (TVOC, TSVOC, etc.). Testing is performed in line with EN 16516, considering European directives on hazardous substances.

2. Introduction

Any testing to determine the emissions of products must be performed by a testing laboratory whose accreditation to ISO 17025 includes tests according to this GEV testing method or EN 16516.

Documentation of the results is done by the manufacturer according factory-internal rules.

2.1 Scope

Determination of the emission of volatile organic compounds (VOC) from products:

(1) Testing covers a number of substances as specified in 3.4 that are recognised or suspected carcinogens (C1A, C1B) according to the European directives on hazardous substances.

(2) Testing covers polar and non-polar substances that vaporise and appear in gaseous form after a defined storage period.

The testing conditions reflect usual and average ventilation and climate in Central European buildings.

They allow a comparative rating of products with regard to their long-term emissions behaviour and the general exclusion of recognised and suspected carcinogens. The test results are reported as air concentrations under precisely defined conditions, as specified in EN 16516 as European Reference Room.

2.2 Abbreviations

1C = one-component

2C = two-component

VOC = volatile organic compound
(covering the range *n*-hexane (n-C$_{6}$) to *n*-hexadecane (n-C$_{16}$))

TVOC = total volatile organic compounds

SVOC = semi-volatile organic compound
(covering the range above *n*-hexadecane (n-C$_{16}$) to *n*-docosane (n-C$_{22}$))

TSVOC = total semi-volatile organic compounds

VVOC = very volatile organic compound
(covering the range below *n*-hexane (n-C$_{6}$))

TIC = total ion current chromatogram

2.3 Apparatus

- Tools for sample application (see also 3.2)
- Glass plates:
    - the size depends on the chamber volume and the intended loading factor;
    - degrease and clean the plates prior to testing, using a suitable procedure that does not affect the blank value;
- Glass dishes with a flat bottom (e.g. Petri dishes) or glass plates with a rim:
    - the size depends on the chamber volume and the intended loading factor;
    - degrease and clean the dishes prior to testing, using a suitable procedure that does not affect the blank value;
- Product specific moulds made of inert material to prepare a test specimen each for, e.g.:
    - Screeds and screed materials
    - Levelling compounds
    - Joint fillers or sealants
    - Joint insulations
    - Joint sealing tapes
- Notched trowel TKB-B1
  The trowel has triangular notches with the following dimensions:

Dimension			Tolerance
a	Bridge width / groove clearance	2.6 mm	± 0.1 mm
b	Notch width / groove width	2.4 mm	± 0.1 mm
c	Notch depth / groove depth	2.0 mm	± 0.1 mm
γ	Notch angle	55 °	± 0.5 °

- Non-emitting tape or aluminium foil for sealing of edges
- Test chamber:
    - Volume of the test chamber: Minimum 100 litres
    - Material: Stainless steel or glass
    - Air clean-up unit and humidification unit
    - Flow-meter for adjustment and documentation of the air flow rate through test and storage chambers
- Sampling devices for test chamber air
- Adsorbents for air sampling according to 3.4, 3.5 and 3.6
- Conditioning chamber:
  Separate, air-tight conditioning chamber operated at 23 °C, 50 % RH, and an area specific ventilation rate as for emissions testing. Conditioning chambers shall be made of stainless steel or glass.
- Capillary gas chromatographic device with thermal desorption unit, coupled to a mass spectrometer with a data processing unit
- Liquid chromatographic device with a UV absorption detector or a Diode Array detector

3. Procedure

3.1 Sample material

It is the responsibility of the client of the test to supply fresh samples. Samples must be taken promptly after production. The date of production shall be indicated.

3.1.1 Reactive or physically drying products (products for wet application)

Products shall be tested not later than four months after sampling. The samples are usually dispatched in a commercially available package. The content is mixed uniformly by the test laboratory, and a retained sample is taken out.

3.1.2 Non-reactive or non-physically drying products (solid products)

Samples shall be tested not later than eight weeks after production.

Underlays, sealing membranes, and similar products can be sent in original packaging or as representative sample. Take the sample from a position 2 m into the roll. In case of a wide roll, take a sample with an area of at least 1 m^2 from the centre of the roll. In case of a roll less than 1 m wide, take a sample of sufficient length over the whole width.

Roll the sample as far as possible against the direction of the production roll. Secure the sample (if possible) using staples, wrap it twice in aluminium foil and pack it in unprinted and airtight polyethylene or polypropylene foil. Each foil must contain only one sample. The elapsed time between taking and packing the sample must not exceed 1 hour.

Panels and assembled products are preferably dispatched in a normal commercial package unit, additionally wrapped twice in aluminium foil, and packed in unprinted and airtight polyethylene or polypropylene foil.

3.2 Preparation of the test specimens

One-component products are homogenised before preparing the test specimen. For two- or multi-component products each component first is homogenised and then mixed as prescribed by the manufacturer before preparing the test specimen.

The test specimens are prepared in different ways, depending on the nature of the respective product. The sample preparation is described below according to the product type. The assignment of the product types to the test method is given in the “GEV Product Index”.

The preparation of the test specimens has to be done exactly according to the following specifications. A higher application amount is possible if requested by the client.

3.2.1 Procedure for large area applications (loading factor 0.4 m^2/m^3)

3.2.1.1 Procedure for water based to be diluted products that are tested with 100 g/m^2 application amount

If the solids content is not reported by the manufacturer, determine it by drying a separate part of the sample at 105 °C until constant weight, as described in ISO 1625.

Use water which is free of VOC to adjust the sample to 10 % solids content based on the reported (alternatively the measured) solids content of the original sample and homogenise. Pour as much of the (possibly diluted) sample into a pre-weighted glass dish (see 2.3) such that it is loaded with 100 ± 5 g/m^2. If the solids content of the product is lower than 10 % then add more into the dish until a loading of 10 ± 1 g/m^2 solids is reached. Wet the bottom evenly by swinging the dish. If this is not sufficient, a brush can be used for spreading. Transfer the test specimen into the test chamber immediately after preparation. After testing is completed the test specimen is weighed back to ensure that the dried film weighs 10 ± 1 g/m^2.

3.2.1.2 Procedure for liquid products that are tested with 100 g/m^2 application amount

Test an undiluted sample with an amount of 100 ± 5 g/m^2 as described in 3.2.1.1. If necessary, a brush can be used for spreading. There is no need to weigh the sample back after testing is completed.

3.2.1.3 Procedure for products that are tested with 300 g/m² application amount

If necessary, mix the components as specified by manufacturer. Transfer the sample in excess onto a pre-weighed glass plate (see 2.3) and spread it with a notched trowel TKB-B1 (60° blade angle) in one stroke. This shall be carried out in such a way that the sample is uniformly structured across the whole area. Full coverage application in glass dishes with a flat bottom and a rim is performed if the above procedure cannot be applied to products with low viscosity. Weigh the plate back and record the weight of the specimen. The sample must weigh 300 ± 10 g/m². A higher application amount is possible if requested by the ordering body.

The preparation shall not take more than 3 minutes. Transfer the test specimen into the test chamber immediately after preparation.

3.2.1.4 Procedure for products that are tested with 3 mm layer thickness

Mix the sample uniformly according to the instructions given by the manufacturer using water that is free of VOC, or with a supplied liquid component. Let the mixture stand for about 5 minutes and mix thoroughly once again. Prepare products with a shorter processing time (e.g. quick cements) as specified by the manufacturer.

Apply an even layer onto a glass plate (see 2.3) in 3 mm thickness and smooth the surface with a straight trowel.

Fix the edges of the loaded surface using an emission free rim of sufficient height that is made of e.g. glass or stainless steel. Transfer the test specimen with the rim into the test chamber immediately after preparation.

3.2.1.5 Procedure for products that are tested with 12 mm layer thickness

Mix the sample uniformly according to the instructions given by the manufacturer using water that is free of VOC, or with a supplied liquid component. Let the mixture stand for about 5 minutes and mix thoroughly once again.

a) Cement and calcium sulfate based **screed mortars** are mixed with water that is free of VOC as specified by the manufacturer.

b) The same applies to cement and calcium sulfate based **screed binding materials**. But as primary step, mix 1000 g sand with 250 g binding material and water that is free of VOC as specified by the manufacturer. The sand shall be of grain size 0-8 mm and shall be supplied by the manufacturer. In case of control samples, sand of mesh type B8 as specified in DIN 1045-2 shall be used.

c) **Screed and concrete admixtures** are prepared as like screed binding materials, but use a defined Portland cement CEM I 42,5 N to be supplied by the manufacturer instead of the binding material. Mix 250 g Portland cement with 1000 g sand (0-8 mm) and water that is free of VOC and the maximum dosage of the screed additive admixture as specified by the manufacturer.

Apply an even layer of the mixed sample onto a glass plate (see 2.3) in 12 mm thickness and smooth the surface with a straight trowel.

Mix the sample uniformly according to the instructions given by the manufacturer using water that is free of VOC, or with a supplied liquid component. Let the mixture stand for about 5 minutes and mix thoroughly once again.

3.2.1.6 Procedure for products that are tested with 3 kg/m² application amount

Mix the components as specified by manufacturer. A glass dish with a flat bottom and a rim is covered over the whole surface with an application amount of 3 kg/m².

Transfer the test specimen into the test chamber immediately after preparation.

3.2.1.7 Procedure for the testing of surface treatment products

Pour as much of the sample into a pre-weighted glass dish (see 2.3) that the following application amounts are transferred into the test chamber or preconditioning chamber:

a)	For water based lacquers for parquet:	150 ± 2 g/m^2
b)	For water based lacquers for and finishes and oils for mineral floorings:	100 ± 2 g/m^2
c)	For water based lacquers for resilient floorings:	50 ± 2 g/m^2
d)	For oils:	25 ± 2 g/m^2
e)	For water based primers for parquet:	100 ± 2 g/m^2
f)	For water based joint fillers for parquet:	100 ± 2 g/m^2
g)	For water based UV lacquers:	150 ± 2 g/m^2
h)	For UV curing lacquers with 100% solids	50 ± 2 g/m^2

Wet the bottom evenly by swinging the dish. Distribute evenly with a brush if necessary. Transfer the test specimen into the conditioning chamber immediately after preparation.

Alternatively, the same quantity can be applied on a glass plate.

Even though testing of parquet lacquers, primers and oils on wooden substrate is not recommended[1], results from such testing can be taken into account for an evaluation of emissions.

Testing with several layers on wood, with in total higher application, is not recommended but is possible. In that case drying periods between the layers shall be applied as specified by the manufacturer.

After wet application, water-based UV lacquers are dried physically according to the manufacturer's instructions. UV-curing lacquers with 100 % solids are ventilated for 30 minutes after application. UV curing is then carried out according to the manufacturer's specifications using a suitable device.

3.2.1.8 Procedure for solid products

The sample is unpacked in the testing laboratory immediately prior to testing. The material to be tested is taken out of the middle of the package. For products on a roll, at least 2 m must be unrolled. The test specimen is either cut or put together to the proper size for testing. The back side is fixed tightly onto an inert plate. A product with a self-adhesive back side is glued directly onto the plate with its full surface. Remove the protective foil from products with a self-adhesive upper side. All open edges of products more than 1 mm thick shall be sealed with an inert material, e.g. a non-emitting tape or aluminium foil. Materials used for sealing of back and edges must be shown to be emission-free. Testing without such sealing is possible as well.

3.2.2 Procedure for small area applications (loading factor 0.007 m^2/m^3)

3.2.2.1 Procedure for Joint sealants

Apply the sample without bubbles into a mould made of inert material (e.g. stainless steel, glass, Teflon) with 3 mm depth and 10 mm width and smooth the surface with a straight trowel (e.g. made of Teflon). The length of the mould shall correspond to the required loading factor and the size of the test chamber.

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[1] Testing on wood is not recommended, because the emissions from the wood itself, and different porosity of different wooden plates, can deteriorate the test result.

3.2.2.2 Procedure for expanding installation and insulation foams

A moistened mould made of HDPE or Teflon is filled with foam in a circa 30 mm thick layer. The form has a width of 100 mm and a height of 16 – 19 mm. After 2 hours (120 ± 10 minutes) the test specimen is cut flatly to 16 – 19 mm height and it is placed into a 15 mm wide and 100 mm deep sample holder (U profile with covered edges, trough shaped) made of inert material (e.g. stainless steel, glass, Teflon) with this slight oversize. The length of the form and of the sample holder shall correspond to the required loading factor and the size of the test chamber.

3.2.2.3 Procedure for joint sealing tapes (according to DIN 18542)

A sample of the tape is placed into a 15 mm wide and 100 mm deep sample holder (U profile with covered edges, trough shaped) made of inert material (e.g. stainless steel, glass, Teflon). The length of the sample holder shall correspond to the required loading factor and the size of the test chamber.

3.2.3 Procedure for wall applications (loading factor 1.0 m²/m³)

3.2.3.1 Prodedure for mineral- and gypsum-based plasters

Mix the sample uniformly according to the instructions given by the manufacturer using water that is free of VOC.

Apply an even layer onto a glass plate (see 2.3) in 3 mm thickness and smooth the surface with a straight trowel.

Fix the edges of the loaded surface using an emission free rim of sufficient height that is made of e.g. glass or stainless steel. Transfer the test specimen with the rim into the preconditioning chamber immediately after preparation.

3.2.3.2 Procedure for mineral- and dispersion-based finishing and top plasters

Mix the components as specified by the manufacturer, unless the product is ready to use. The sample is homogenized and a glass dish with a flat bottom and a rim is covered over the whole surface with an application amount of 2.5 kg/m². Transfer the test specimen into the preconditioning chamber immediately after preparation.

3.2.3.3 Procedure for wall filler

If necessary, mix the components as specified by the manufacturer. Transfer the sample onto a pre-weighed glass plate (see 2.3) and spread it with a flat trowel. This shall be carried out in such a way that the sample is uniformly structured across the whole area. Weigh the plate back and record the weight of the specimen. The sample must weigh 300 ± 10 g/m². Transfer the test specimen into the test chamber immediately after preparation. Wall filler shall not be preconditioned.

3.2.3.4 Procedure for wall panels

The sample is unpacked in the testing laboratory immediately prior to testing. The material to be tested is taken out of the middle of the package. The test specimen is either cut or put together to the proper size for testing. The back side is fixed tightly onto an inert plate or aluminium foil. All open edges of products more than 1 mm thick shall be sealed with an inert material, e.g. a non-emitting tape or aluminium foil. Materials used for sealing of back and edges must be shown to be emission-free. Testing without such sealing is possible as well.

3.3 Operation of the test chamber and conditioning chamber

Parameters not specified differently in this GEV testing method shall follow EN 16516.

3.3.1 Preparation of the test chamber

Prior to emission testing a blank check of the test chamber has to be carried out. The blank values as specified in EN 16516 with reference to EN ISO 16000-9 must not be exceeded. Clean the test chamber if necessary, before placing the test specimen into the chamber. After cleaning the blank value has to be checked.

3.3.2 Operating parameters

The following parameters shall be adjusted in the test chamber:

Parameter	Value	Tolerance
Temperature (chamber and supply air)	23 °C	± 1 °C
relative humidity (supply air)	50 %	± 5 %
area specific air flow rate (usually defined by the parameters air exchange rate and loading factor)	1.25 m^3 / (m^2 x h) or 71 m^3 / (m^2 x h) (joint sealants, sealings and tapes)	results from tolerance of air change and loading
air exchange rate in test chamber	0.5 h^{-1}	0.25 – 1.5 h^{-1}*, ± 5 % during test
loading factor for wall products	1.0 m^2/m^3	0.5 – 2.0 m^2/m^3
loading factor for large surfaces	0.4 m^2/m^3	0.2 – 0.8 m^2/m^3*
loading factor for small surfaces	0.007 m^2/m^3	0.0035 – 0.014 m^2/m^3*
air flow (measured 10 mm above centre of sample)	0.2 m/s	0.1 – 0.3 m/s

* The parameters shall comply with the specified values in the second column. In the case of deviations, the parameters shall be within the specified tolerance ranges, and the results shall be calculated back to the specified values as outlined in EN 16516.

3.3.3 Control measures and documentation

A continuous measurement and documentation of the parameters temperature, humidity and air flow is recommended to be performed by suitable sensors.

The efficiency of air mixing with a test specimen or an inert support of test specimen loaded in the test chamber (for methodology, see EN ISO 16000-9) shall be evaluated within the quality assurance program. The result has to be documented.

3.3.4 Pre-conditioning and transfer of the test specimen into a chamber

Products specified in 3.2.1.7 shall be stored in a separate pre-conditioning chamber for 3 days (72 ± 1 hours). Testing is possible without such pre-conditioning as well if requested by the ordering body.

Products specified in 3.2.3.1 and 3.2.3.2 shall be stored in a separate pre-conditioning chamber for 7 days (168 ± 1 hours). Testing is possible with a shorter or without such pre-conditioning, provided that the relative humidity in the test chamber during sampling after 3 days is in the range of 50 ± 5% and if requested by the ordering body.

Test specimens must be transferred into the chamber immediately after preparation. Any contamination of test specimens with emissions from other sources must be avoided. The loading of the test chamber shall be adjusted according to 3.3.2.

3.3.5 Periods in the chambers and time schedule of air sampling

Air sampling for first VOC test and for aldehydes test is performed 3 days (72 ± 1 hours) after transfer of the test specimen into the Start time and end time of air sampling shall be within the specified interval of ± 1 hour.

Then the test specimen has to remain in the test chamber until finalizing all later air sampling.

Air sampling for long-term emissions test is performed 28 days (672 ± 4 hours), after transfer of test specimen into test. Start time and end time of air sampling shall be within the specified interval of ± 4 hours.

Alternatively, compliance can be shown if all criteria (28 days limit values) are respected already at an earlier point of time, but not earlier than after 10 days, under the condition that the emissions did not increase, compared with the emissions after 3 days.

3.4 Testing of carcinogenic substances cat. 1

Emission testing is carried out 3 days and 28 days after start of test in the test chamber for volatile carcinogenic compounds cat. 1A and 1B[2].

An analytical reporting limit of 1 µg/m³ for each carcinogenic substance shall be targeted, as far as technically feasible. Test methods are specified below.

Testing method as specified in 3.5 and 3.6 shall be applied. Carcinogenic substances of cat. 1A and 1 B are monitored within the frame of the above specified emissions tests without additional sampling or analysis.

The emissions of formaldehyde and acetaldehyde are tested and evaluated separately after 3 days.

3.5 Testing of the emissions of aldehydes and ketones

Reference: DIN ISO 16000-3

3.5.1 Air sampling

Air sampling shall be performed after 3 days. An additional air sampling shall be performed after 28 days for evaluation of the R value for assignment of the EC 1$^{\text{PLUS}}$ level. Air sampling is performed onto silica gel or filters which both are impregnated with dinitrophenylhydrazine (DNPH), or into an aqueous solution of DNPH. Exposed DNPH filters must be analysed within two days after sampling to avoid loss of formaldehyde.

3.5.2 Analysis

Desorption with acetonitrile, separation by HPLC, identification and quantification by UV absorption detector or by diode-array detector with one or two specific wavelengths.

To avoid wrong results the analyst should pay attention to a complete chromatographic separation.

If a signal is present at the specific retention time in the chromatogram, it will be checked, whether the limit value for the given substance (see "GEV-Classification Criteria" par. 3.2.1) is exceeded. Further it shall be checked whether the spectrum of the signal peak is in accordance with the spectrum of the standard.

The analysis shall identify and quantify the following substances after 28 days for calculation of the R value: Formaldehyde, acetaldehyde, acetone.

3.6 Testing for VOC, SVOC and VVOC emissions

Air sampling and analysis shall be carried out in such a way that each single substance can be identified and quantified in the chamber from 1 µg/m³ on, as far as technically feasible.

3.6.1 Air sampling

The adsorption tubes are conditioned prior to sampling in a flow of helium as specified in EN ISO 16000-6. Take air samples on Tenax TA 60/80 with max. 120 ml/min, e.g. during 60 minutes, with a volume of max. 5 litres. Duplicate air sampling shall be performed. To avoid any loss of VOCs due to overloading, either two tubes (main and control tube) shall be connected in series, or two parallel sampling tubes shall be used with different air sampling volumes, e.g. 2 and 5 litres.

Volatile compounds such as acetic acid are poorly adsorbed by Tenax TA (low capacity). For these compounds the result from the adsorption tube with the lower air sampling volume is decisive.

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[2] A list of classified carcinogenic compounds (cat. 1A and 1B) can be seen here (in German language): http://www.dguv.de/ifa%3B/fachinfos/kmr-liste/index.jsp. A supplemental support for identification of relevant VOCs is the most recent list used by Deutsches Institut für Bautechnik (DIBt) as can be found in the evaluation file ADAM.

The use of active charcoal as adsorbent is not accepted, because charcoal has a very poor recovery rate in the case of polar compounds (e.g. alcohols, glycol ethers etc.).

3.6.2 Analysis

3.6.2.1 Desorption and injection

The operating parameters depend on the analytical devices in use and shall be determined and adjusted by the testing laboratory. The following parameters are examples referring to the system Perkin-Elmer ATD-400.

Desorption of the tubes after air sampling by heating to e.g. 300 °C in a flow of helium, as specified in EN ISO 16000-6. It is recommended to carry out double desorption for a reliable determination even of less volatile compounds. Concentration step: Cryofocussing in a cold trap at -30 °C. Injection by rapid heating of the cold trap, e.g. up to 300 °C in one minute.

3.6.2.2 Gas chromatography

Capillary gas chromatography, with 5 % phenyl / 95 % methylpolysiloxane, with helium as carrier gas, e.g. with a column of 30 m in length, inner diameter (ID): 0.25 mm, film thickness (d): 0.25 µm.

The GC analysis has to be carried out in a way that allows a reliable detection of substances including *n*-docosane (*n*-C_{22}).

3.6.2.3 Identification

By comparing spectra using the fragment ions or in the SIM mode using a scan range from 33-425 amu. Identification of all single components, but only if they result in more than 1 µg/m³ concentration, when calculated from the TIC in toluene equivalents.

The identification is described in the following categories of identity:

- **ID Category 1:** **definitely identified**
  Prerequisite: The retention time and the mass spectrum of the signal peak matches with those of a standard.
- **ID Category 2:** **probably identified**
  Prerequisite: The mass spectrum of the signal peak matches with a reference spectrum of a standard library, the retention time is in the expected time interval, and there is additional evidence for the identity (e.g. the presence of other isomers of the substance).
- **ID Category 3:** **possibly identified**
  Prerequisite: as category 2, but less stringent evidence.
- **ID Category 4:** **not identified**
  Prerequisite: no reliable evidence for the identity.

3.6.2.4 Quantification

Calibration shall be performed as specified in EN 16516. Use of an internal standard is possible only if it is ensured that there is no overlapping between the internal standard peak and peaks of the air sample.

The definitely identified compounds (category 1):

- Substances for which there is a limit value are quantified using the relative response factors with the respective signal areas in the TIC, or - in the case of insufficient chromatographic separation - by using the response factors of characteristic fragment ions.
- All other substances are quantified using the respective signal areas in the TIC with toluene as reference substance for calibration (in toluene equivalents).

The single results of the main sampling and the control sampling tube are added if relevant. If the amount of single compounds in case of the control sampling tube is more than 25 % higher than the amount adsorbed on the main sampling tube then the result has to be marked with "greater than", because relevant loss of substances cannot be excluded.

Only compounds with more than 5 µg/m³ concentration when calculated from the TIC in toluene equivalents, are considered for TVOC and TSVOC and R-value calculation. Quantified substances with less than 5 µg/m³ shall be reported as "< 5 µg/m³" or "less than 5 µg/m³" because lower results show an increased measurement uncertainty not allowing more precise information. Precise data down to 1 µg/m³ shall be given only for carcinogenic substances, as far as technically feasible. Results for acetic acid are not included in the calculation of TVOC and of the R value, as EN 16516 states that a reliable determination of acetic acid is not possible with this testing method.

3.6.2.5 Complex substance mixtures

Complex mixtures of aliphatic hydrocarbons (saturated, unsaturated, cyclic, acyclic) that are not separated in a gas chromatogram and appear as a "cluster" of signals are evaluated as follows:

All specific VOCs of chemical nature different than the hydrocarbon mixture are evaluated each by each as far as feasible and quantified in line with 3.6.2.4. The whole area of each peak is calculated, from top of each peak down to baseline. The reporting limits of 3.6 (1st sentence) and 3.6.2.4 are applied.

All other specific VOCs are rated as part of the hydrocarbon mixture and quantified in toluene equivalents in line with 3.6.2.4. The whole area of each peak is calculated, from top of each peak down to baseline. The reporting limits of 3.6 (1st sentence) and 3.6.2.4 are applied.

The test result of the whole hydrocarbon mixture is calculated as the sum of all individual results, but without the VOCs that are chemically different from the hydrocarbon mixture.

Mixtures of aromatic hydrocarbons and of terpenes are treated in a similar manner.

3.6.2.6 Normalization and re-calculation

Test results obtained with higher application amount than specified in this document are compared directly with emissions class limit values without correction, with the exception of the below mentioned products. The measured values are normalized to the standard application amount target application amount as given below, if necessary:

Result (µg/m³) = measured value (µg/m³) x standard application (g/m²) / applied amount (g/m²).

Standard application:

- 10 g /m² dry residue for water based primers
- 100 g/m³ for ready-to-use liquid fixatives and adhesives.

Test results obtained with deviating loading factors or air change rates shall be calculated back to the standard values as follows:

Result (µg/m³) = Measured value (µg/m³) x Standard value of loading factor (m²/m³) / Applied loading factor during test (m²/m³).

Result (µg/m³) = Measured value (µg/m³) x Applied air change rate during test (per hour) / Standard value of air change rate (per hour).

3.6.2.7 TVVOC, TVOC, TSVOC, R-Value, sum VOC without LCI (NIK)

The results are summed up to the following parameters, depending on the retention time of the individual compounds on a - slightly polar column, see 3.6.2.2:

- TVOC:
  All compounds with more than 5 µg/m³ in the gas chromatogram between and inclusive *n*-hexane and *n*-hexadecane (n-C_6 – n-C_{16}), calculated in toluene equivalents (excluding emissions of acetic acid, see 3.6.2.4).

- TSVOC:
  All compounds with more than 5 µg/m³ in the gas chromatogram after *n*-hexadecane (> *n*-C16) and before *n*-docosane (< *n*-C_{22}), calculated toluene equivalents.
- TVVOC (only for products according to 3.2.6):
  All compounds with more than 5 µg/m³ in the gas chromatogram before *n*-hexane (< *n*-C_6), calculated in toluene equivalents.
- Others:
  For EC1**PLUS** the R-value (excluding emissions of acetic acid, see 3.6.2.4) and the sum of non-assessable VOCs are reported as specified by AgBB in the most recent version. This includes VVOC and SVOC with an LCI value as well that are determined by sampling on Tenax and on DNPH tubes

3.6.2.8 Precision and accuracy

A repeatability of test chamber air monitoring with the same test specimen within one testing laboratory of ± 20 % or better should be aimed at. A larger variation has to be accepted in the trace range below 5 µg/m³.

The testing laboratory shall take special care to ensure traceability and accuracy of the calibration, and to know and consider recovery rates.

3.7 Documentation of results

3.7.1 Internal documentation in the testing laboratory

- Sample:
  Name, package, batch and date of production (if known), solids content (in case of primers), date of receipt in the laboratory.
- Test specimen:
  Glass plate (length, width), possibly mixing procedures before application, amount of sample (weight before and after preparation of the test specimen), spreading technique (used tool).
- Test chamber and conditioning chamber:
  Type and dimensions, temperature (mean and course), relative humidity (mean and course), air flow (in litres per hour, mean and course).
- Air sampling:
  Time (after preparation of test specimen), duration, adsorbent, sampling air flow, sampling volume.
- Storage:
  Storage time (in full hours) in the test chamber / conditioning chamber
- Results:
  All readings either as average or as single results of duplicate determination.

Documentation and storage of the raw data is done according to the Quality Assurance System (QA System) of the testing laboratory.

3.7.2 Report to the customer

The summarising report to the customer includes at least a statement on the presence or absence of the C-substances according to 3.4 and documentation on the emissions according to 3.5 and 3.6 at all testing dates.

3.7.3 Storage of data

The documentation of the results have to be stored by the testing laboratory for at least 10 years, back-up samples of the tested products for 2 months and the analytical raw data (TIC, mass spectra etc.) for at least 10 years. Apart from that the rules of the quality system concerning the storage of data shall be observed

3.8 Quality Control

Control cards shall be used for the test chambers and for the analytical methods.

Blank control shall be carried out by air sampling prior to starting any test.

Control air sampling efficiency as specified in 3.6.1. Duplicate air sampling is essential to avoid random errors.

Control of all calculations and of each data transfer between two sheets or into EDP shall be carried out by a second person.

In regular intervals two test specimens are prepared from one single sample and the emissions are compared for checking reproducibility. Furthermore, recovery is determined by introducing a known amount of a compound into the test chamber which is inert and not emitted from the sample in the chamber.

To control the analysis method sampling tubes spiked with substance of known quantity are analysed regularly.

4. Revision of this method

The Technical Council of the GEV is responsible for the contents of this test method. The GEV is responsible for all the documentation and for any revisions.

5. References

EN 16516

EN ISO 16000 parts 3, 6, 9 and 11

ISO 17025

DIN 1045-2