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Emission safety of combustible air fresheners — Test methods

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National foreword

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Emission safety of combustible air fresheners - Test methods

Sécurité des émissions des désodorisants à combustion - Méthodes d'essais

Emissionssicherheit brennbarer Lufterfrischer - Testverfahren

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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European foreword

This document (EN 16738:2015) has been prepared by Technical Committee CEN/TC 421 “Project Committee - Emission safety of combustible air fresheners”, the secretariat of which is held by UNI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2016, and conflicting national standards shall be withdrawn at the latest by May 2016.

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1 Scope

This European standard specifies a test method for the determination of emissions resulting from the use of combustible air fresheners into indoor air by means of chamber operation according to EN ISO 16000-9.

This standard defines specific testing conditions for the measurement of the emissions from combustible air fresheners which minimize the effect of the testing on the combustion process.

This standard provides a measurement method for the determination of the following non-exhaustive list of target substances emitted directly from the burning process:

— VOC;

— Benzene;

— Naphthalene;

— Formaldehyde.

The measurement method can allow the determination of other substances.

This standard provides additional information on the optional measurement of the following substances:

— SO_2;

— NO_x;

— CO.

This standard is not suitable for the quantitative determination of particulate matter.

This standard does not apply to non-combustible air fresheners and loose incenses.

Any scented candle with burning time shorter than 2,5 h is outside the scope of the standard.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 717-1, *Wood-based panels - Determination of formaldehyde release - Part 1: Formaldehyde emission by the chamber method*

EN 14211, *Ambient air - Standard method for the measurement of the concentration of nitrogen dioxide and nitrogen monoxide by chemiluminescence*

EN 14212, *Ambient air - Standard method for the measurement of the concentration of sulphur dioxide by ultraviolet fluorescence*

EN 14626, *Ambient air - Standard method for the measurement of the concentration of carbon monoxide by non-dispersive infrared spectroscopy*

EN 14789, *Stationary source emissions - Determination of volume concentration of oxygen (O2) - Reference method - Paramagnetism*

EN 14792, *Stationary source emissions - Determination of mass concentration of nitrogen oxides (NOx) - Reference method: Chemiluminescence*

EN 15058, *Stationary source emissions - Determination of the mass concentration of carbon monoxide (CO) - Reference method: Non-dispersive infrared spectrometry*

EN 15426, *Candles - Specification for sooting behaviour*

EN ISO 16000-9, *Indoor air - Part 9: Determination of the emission of volatile organic compounds from building products and furnishing - Emission test chamber method (ISO 16000-9)*

EN ISO 16017-1, *Indoor, ambient and workplace air - Sampling and analysis of volatile organic compounds by sorbent tube/thermal desorption/capillary gas chromatography - Part 1: Pumped sampling (ISO 16017-1)*

ISO 16000-3, *Indoor air — Part 3: Determination of formaldehyde and other carbonyl compounds in indoor air and test chamber air — Active sampling method*

ISO 16000-6, *Indoor air — Part 6: 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 or MS-FID*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
combustible air freshener
product constituted by a fragranced combustible material which by action of combustion releases in the air smelling substances which it contains (e.g.: scented candle, incense, catalytic lamp, etc.)

3.2
candle
one or more combustible wicks supported by a material that constitutes a fuel, which is solid, semisolid or quasi-rigid at room temperature (20 °C to 27 °C), the combined function of which is to sustain a light-producing flame

Note 1 to entry: It can also contain additives, which are used for colour, odour, stability, or to modify the burning characteristics; including candles with decoration attached to or contained within them.

3.2.1
scented candle
candle in the fuel of which a fragrance intended to be released is added

3.3
indoor air
air within an enclosed space, e.g. dwelling or public building

3.4
scented oil lamp (for indoor use)
container in which scented oil is burned at the wick

3.5
incense
dried plants (herbs or wood) which are pulverized and mixed with resins

Note 1 to entry: The sticks in incense sticks may be of sandalwood, bamboo or similar material that has the ability to burn together with the wrapped plant ingredients. Some incense mixtures are composed of dried and finely chopped herbs, woods and roots, others from resins and balsams as small pellets or granules. Incense may be mixtures but may also consist of one single type of incense based on single plants or plant parts. Besides, natural or synthetic essential oils can be added. Four common types of incense exist: loose incense (granulate or powder), cones, incense sticks with and without solid stick.

3.6
catalytic lamp
system based on the catalytic combustion of a combustible liquid by using a catalytic burner composed of porous material which is made of synthetic or mineral materials

Note 1 to entry: The product requires also a wick that feeds the burner from the liquid container by capillarity, a cap designed to stop operation of the catalytic lamp and openwork mounting for protection and ventilation.

The catalytic lamp diffuses perfume and combustibles in the air. It perfumes and destroys smells, at the same time.

3.6.1
catalytic burner
burner composed of a porous material made from synthetic or mineral material and a specific catalyst in the catalytic oxidation of solvent which favours the production of carbon dioxide and water

3.7
unit specific emission rate
***SER*$_U$**
product specific rate describing the mass of a volatile organic compound emitted per unit ($_U$) of combustible air freshener per unit of time at a given time from the start of the test

3.8
burn rate
BR
mass of material burned per unit of time under test conditions

3.9
background of the test chamber
emission level of the test chamber operated with all the equipment except the specimen

3.10
test specimen
sample intended for emission testing in an emission test chamber

4 Test methods

4.1 Principles

The principle of the test is to determine the unit specific emission rate (SER_u) of emissions resulting from the use of combustible air fresheners. The test is performed under controlled conditions in an emission test chamber according to EN ISO 16000-9. The air in the emission test chamber is fully mixed and measurements of a substance concentration in the air at the test chamber outlet are representative of the emission test chamber concentrations for that substance.

Unit specific emission rates, SER_U, at a given time, t, are calculated from the emission test chamber air concentrations, C, the air change rate, n, and number of test specimens at the same time in the test chamber, N. With knowledge of the concentration in the outlet air, the air flow through the emission test chamber and the number of the test specimens, the unit specific emission rates of emissions from the product under test can be determined.

4.2 Apparatus

Dynamic environmental emission test chamber according to EN ISO 16000-9, and a suitable number of wire mesh cylinders type 2 according to EN 15426.

4.3 General test conditions

4.3.1 General

Combustible air fresheners are ignited and burned in the test chamber using the parameters specified in Table 1 until a state of equilibration is reached.

Dynamic emission test chamber according to EN ISO 16000-9 using inlet air at 23 °C and 50 % relative humidity with 2 air changes per hour.

If the burn rates data outside the chamber are not available the data can be provided by a burning test run outside the test chamber and for candles it will be according to EN 15426 for the minimum testing time in the test chamber.

The test protocol and test conditions of the chamber experiment are defined in such a way that standardized (well controlled) burning processes inside the chamber are guaranteed.

Parameters to be controlled are:

— air mixing inside the chamber;

— avoidance of disturbance of the flame, burning in draught free conditions and no flickering;

— composition of the stand on which the candle is positioned;

— temperature;

— relative humidity;

— oxygen concentration.

4.3.2 Test chamber volume

The test chamber volume shall be 1,0 m^3 ± 0,1 m^3.

Test chambers with larger volumes may be accepted provided that sufficient data support evidence of comparable results. Sufficient data requires a validation study with a minimum of 10 comparative tests between a 1 m^3 chamber and another chamber and successful participation in the Round Robin Test with a minimum of 5 participating laboratories.

4.3.3 Number of test specimens at the same time in the test chamber

Number of test specimens as defined in Table 1.

Table 1 — Chamber test

Type of test specimen	Burning time in h	Air change per hour (n) in h^{-1}	$Time_{eq}$ (equilibration time before air sampling) in minutes	Number of specimens inside the chamber	Number of specimens outside the chamber	Sampling time in minutes
Scented candle	≥ 4	2,0 ± 0,2	120 ± 5	2	3	60 ± 5
Scented candle	≥ 2,5 and < 4	2,0 ± 0,2	90 ± 5	2	3	60 ± 5
Incense	not relevant	2,0 ± 0,2	5 ± 1	2	optional	adjust to combustion time, maximum 60
Oil lamp	not relevant	2,0 ± 0,2	120 ± 5	2	optional	60 ± 5
Catalytic lamp	not relevant	2,0 ± 0,2	120 ± 5	2	optional	60 ± 5
Scented candle with 2 or more wicks	> 4	2,0 ± 0,2	120 ± 5	1	1	60 ± 5

Sampling for incense shall be stopped at the end of combustion of the first test specimen to a maximum of 60 min.

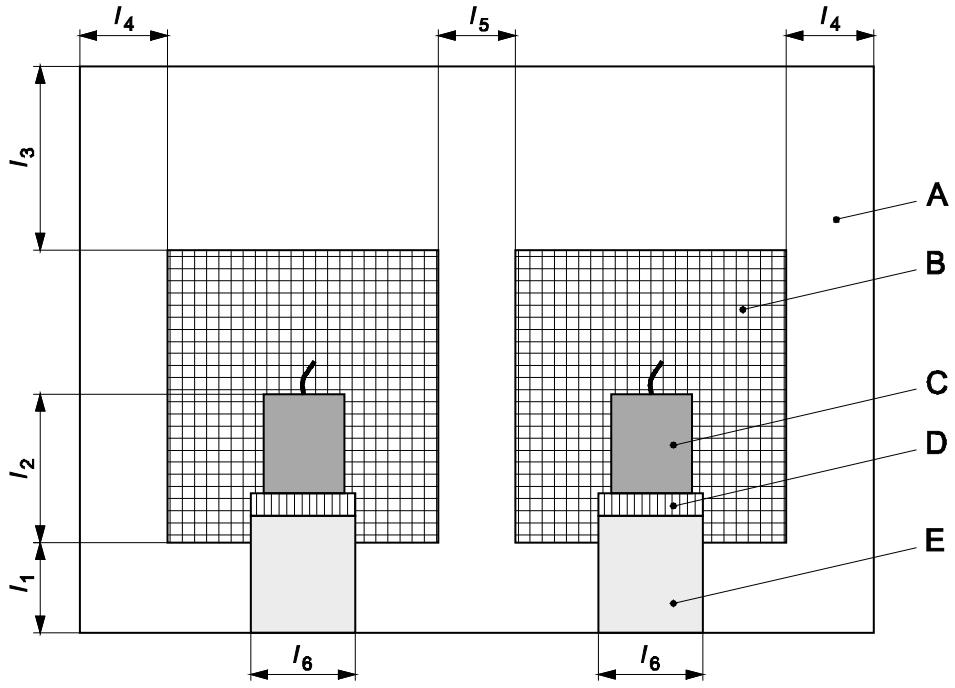
4.3.4 Positioning of test specimens in the test chamber

4.3.4.1 Scented candle, incense and oil lamp

Place the test specimens in an upright position on a heat resistant, non-flammable surface. Non free-standing candles and incense sticks are placed in a suitable holder which does not affect the burning property and the emissions. Free-standing test specimens are placed on a glass surface that does not affect the burning property. The stand "E" shall be made of inert material (e.g.: glass, stainless steel, etc.) that does not affect the burning property. Floating candles are placed in a suitable bowl filled with water. Position the wire mesh cylinder (type 2 of EN 15426) centrally above the sample. Adjust the distance (see Figure 1, l_2) between the top of the solid base material and the bottom of the wire mesh cylinder to 150 mm (see Figure 1, l_2). A gap (see Figure 1, l_1) of at least 50 mm should remain between the bottom of the cylinder and the bottom of the chamber. If the gap is smaller the test specimen shall be placed on a stand to put it in a higher position. The diameter of this stand shall not exceed 1/3 of the diameter of the wire mesh cylinder, as the air exchange within the cylinder would otherwise be hindered (see Figure 1). One wire mesh cylinder with the appropriate diameter as specified in EN 15426 shall be used per test specimen. The distance between two wire mesh cylinders shall be at least 50 mm (see Figure 1, l_5) from edge to edge and the distance between wire mesh cylinders and test chamber walls shall be at least 100 mm (see Figure 1, l_4). The distance between the top of the wire mesh cylinder and the ceiling of the test chamber shall be at least 300 mm (see Figure 1, l_3).

NOTE A suitable bowl is made from a heat resistant material and filled with water to a level less than 1 cm below the edge.

Dimensions in millimetres



Key

l_1	≥ 50 mm	A	test chamber
l_2	150 mm	B	wire mesh cylinder
l_3	≥ 300 mm	C	freestanding test specimen
l_4	≥ 100 mm	D	glass surface
l_5	≥ 50 mm	E	stand (if necessary for distance)
l_6	≤ 1/3 of the diameter of the wire mesh cylinder		

Figure 1 — How to set up the equipment

4.3.4.2 Catalytic lamp

Place the test specimens in the middle of the test chamber at a minimum distance of 280 mm between each ignition source.

4.3.5 Air supply quality and background concentration

Air supply shall not contain any target substances at levels higher than the emission test chamber background concentrations.

Background concentrations shall be low enough not to interfere with the determination of the compliance with the applicable emission limit values.

The water used for humidification shall not contain interfering target substances.

4.3.6 Test specimen preparation and ignition

4.3.6.1 General

Remove any outer wrapping and label material and prepare the test specimen for use according to the manufacturer's instructions if any given.

4.3.6.2 Scented candles and oil lamps

Adjust the length of the wick if necessary according to the manufacturer's instructions if existing. Place the test specimen in the chamber and ensure the wick is in an upright position and light it with a gas flame. Close the chamber immediately and record the time as the starting time of the test.

4.3.6.3 Incense products

Light the test specimen with a gas flame and blow it out immediately, place the incense in the chamber. Close the chamber immediately and record the time as the starting time of the test.

4.3.6.4 Catalytic lamp

Light the test specimen according to the manufacturer's instructions. Leave the lamp burning for at least 2 min before blowing it out and placing it in the chamber. Close the chamber immediately and record the time as the starting time of the test.

4.3.7 Temperature inside the test chamber during the test

The test chamber is operated at (23 ± 2) °C at the beginning of the test. The inlet air shall remain at (23 ± 2) °C all the time.

The temperature in the test chamber shall be monitored continuously, anywhere below the flame level or under the point of combustion at the beginning of the test, and shall not exceed 30°C over the sampling period.

4.3.8 Relative air humidity inside the test chamber during the test

According to EN ISO 16000-9 the test chamber is operated at (50 ± 5)% RH at the beginning of the test. The inlet air RH shall remain at (50 ± 5)% all the time. RH in the test chamber shall be monitored continuously, anywhere below the flame level or under the point of combustion at the beginning of the test and shall not exceed 80 %.

4.3.9 Oxygen concentration inside the test chamber during the test

Oxygen concentration shall not be lower than 18 %. (See EN 14789.)

4.3.10 Control of the burning process

The test specimens shall burn without noticeable disturbance by draught. If the burning behaviour or flames are disturbed by draught the direction of the air flow shall be modified.

NOTE If the flame of a candle with a diameter of approximately 22 mm is flickering there is a draught, if not then it is flickering due to the test specimen design.

The flames and the burning behaviour of the test specimens shall be visually monitored during the test without opening the test chamber.

Chamber material glass: view into the test chamber from outside.

Chamber material stainless steel: visual control by webcam installed inside the chamber or through a window.

For testing floating candles, the temperature of the water shall be at room temperature when the test is started.

4.3.11 Burn rates

When the sampling is finished, extinguish the test specimens if necessary according to the manufacturer's instructions, if any given. Before starting the test and after extinguishing the test specimens, measure their weight.

The ratio of the difference of the test specimens weight before and after burning and the sum of initial and burning periods according to following equation is recorded as the hourly fuel consumption ($f_{c,h}$).

$$f_{c,h} = \frac{\Delta w}{t_{b,total}}$$

where

$f_{c,h}$ hourly fuel consumption, in g/h;

Δw difference in the test specimen weight before and after burning, in g;

$t_{b,total}$ total burning time of the burning cycles and initial burning cycles, in h.

The average burn rates of the candles outside and inside shall not differ by more than 20 %.

4.3.12 Sampling and analysis of VOC (benzene, naphthalene)

Sampling is run in duplicate and the sampling time is (60 ± 5) min. Collection onto appropriate sorbent tubes with analysis by Thermal desorption GC-MS as stated in ISO 16000-6 and EN ISO 16017-1.

The results of chamber air samples shall be compared for individual compounds before reporting a test result. The compound concentration determined from duplicate air sample shall agree within ± 15 % of the average, after taking the air sample volume into account. If there is any greater disparity, only the higher concentration shall be reported unless there is a good technical reason (e.g. artefact or contamination) why the higher value should be discounted. This should be documented.

NOTE Useful sorbent options include:

a) a weak graphitized carbon black backed up a medium strength graphitized carbon black;

b) a weak graphitized carbon black backed up a medium strength graphitized carbon black further backed up by a carbonized molecular sieve.

ISO 16000-6 describes an analytical procedure to analyse benzene in test chamber atmosphere by collection of test chamber air on the sampling phase Tenax TA®. In presence of combustion gases containing NO_2 the sampling phase Tenax TA® can generate benzene as degradation product resulting in the possibility of false-positive results for benzene. Any low level benzene results from Tenax TA® should be confirmed by independent analysis of graphitized carbon black sorbents. More detailed explanation may be found in CEN/TS 16516:2013, Annex G.

Stronger sorbents, such as carbon molecular sieves, are recommended for monitoring organic compounds more volatile than benzene.

4.3.13 Sampling and analysis of formaldehyde

Sampling is run in duplicate and the sampling time is (60 ± 5) min. Collection in a solution of acetyl acetone/ammonium acetate in water or on DNPH according to EN 717-1 or ISO 16000-3.

The results of chamber air samples shall be compared for individual compounds before reporting a test result. The compound concentration determined from duplicate air sample shall agree within ± 15 % of the average, after taking the air sample volume into account. If there is any greater disparity, only the

higher concentration shall be reported unless there is a good technical reason (e.g. artefact or contamination) why the higher value should be discounted. This should be documented.

NOTE ISO 16000-3 describes an analytical procedure to analyse formaldehyde in test chamber atmosphere by collection of test chamber air on DNPH media. In presence of combustion gases containing NO_2 the sampling phase DNPH may produce false positive formaldehyde concentrations.

4.3.14 Sampling and analysis of NO_2 (nitrogen dioxide)

Use of a continuous measurement device according to EN 14211 and EN 14792.

4.3.15 Sampling and analysis of SO_2 (sulfur dioxide)

Use of a continuous measurement device according to EN 14212.

4.3.16 Sampling analysis of CO

Use of a continuous measurement device according to EN 15058 and EN 14626.

4.4 Procedures of testing

Air samples of non-continuous measurements shall be collected after equilibration time and the exact sampling time according to Table 1 shall be used.

Continuous measurements shall be performed from the closing time of the chamber until the end of the test according to Table 1. Measured concentrations during the sampling interval of the discontinuous measurement shall be averaged. Concentration profiles of the compounds monitored with a continuous monitoring device shall be reported.

4.5 Calculation of results

Unit specific emission rate µg/h per 1 test specimen in test chamber.

The formula for calculation of the emission rate per substance is as follows:

$$SER_{\mathrm{U}} = \frac{\left(C - C_{\mathrm{b}}\right) * n * V}{N}$$

where

SER_{U} unit specific emission rate (µg/h);

C concentration (µg/m³);

C_{b} concentration of the background;

n air change rate of the chamber (h^{-1});

V chamber volume (m³);

N number of specimens in the chamber at the same time.

5 Test report

Any reported results shall be taken from the sampling time period specified in Table 1.

The test report shall provide the following information:

— reference to the standard;

— identification of test specimens;

— chamber volume;

— number of specimens at the same time in the test chamber;

— temperature profile;

— relative humidity profile inside the test chamber;

— oxygen concentration profile inside the test chamber;

— concentration profiles of the tested substances;

— individual hourly burn rates (BR) of test samples inside and outside of the test chamber and their deviation;

— unit specific emission rates (SER_U) of the tested substances;

— any deviations from the test protocol;

— detection limit of the tested substances;

— results/background of test chamber blank;

— material and dimensions of the stand;

— equilibration time before sampling, sampling duration and volume sampled;

— burning time if shorter than sampling time;

— observations on stability and duration of burning (e.g.: flickering flame, dripping, etc.);

— pictures of specimen before and after testing (inside and outside the test chamber), potentially a picture during testing;

— apparatus and analysis methods for each substance.

Annex A
(informative)

Description of sorbent types

Table A.1 — Guidance on sorbent selection

Sorbent Type	Sorbent Name	Compound range	Temperature limits
Weak Graphitized Carbon Black	Carbograph™ [a] 2TD Carbopack™ [b] C Carbotrap™ [c] C	n-C8 to n-C20	Up to 360°C for analysis 380°C for conditioning
Medium strength graphitized carbon black	Carbograph™ 1TD Carbopack™ B Carbotrap™	n-C6 to n-C12/14	Up to 360°C for analysis 380°C for conditioning
Carbon molecular Sieves	Carboxen™ [d] 1003	C3 to n-C6	Up to 360°C for analysis Bring temperature up to 380°C slowly during conditioning
Other absorbents may be used if the manufacturer provides sufficient documentation of their equivalent performance.			

[a] Carbograph™ is a trademark of LARA s.r.l. Italy.

[b] Carbopack™ is a trademark of Supelco, Inc, USA.

[c] Carbotrap™ is a trademark of Supelco, Inc, USA.

[d] Carboxen™ is a trademark of Supelco, Inc, USA.

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[1] CEN/TS 16516:2013, *Construction products - Assessment of release of dangerous substances - Determination of emissions into indoor air*

[2] EN ISO 16000-12, *Indoor air - Part 12: Sampling strategy for polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and polycyclic aromatic hydrocarbons (PAHs) (ISO 16000-12)*

[3] EN ISO 16000-15, *Indoor air - Part 15: Sampling strategy for nitrogen dioxide (NO2) (ISO 16000-15)*

[4] ISO 6768, *Ambient air — Determination of mass concentration of nitrogen dioxide — Modified Griess-Saltzman method*

[5] ISO 7996, *Ambient air — Determination of the mass concentration of nitrogen oxides — Chemiluminescence method*

[6] ASTM D5197-09e1, *Standard Test Method for Determination of Formaldehyde and Other Carbonyl Compounds in Air (Active Sampler Methodology)*

[7] ASTM D6196-03:2009, *Standard Practice for Selection of Sorbents, Sampling, and Thermal Desorption Analysis Procedures for Volatile Organic Compounds in Air*

[8] ASTM D1607-91:2011, *Standard Test Method for Nitrogen Dioxide Content of the Atmosphere (Griess-Saltzman Reaction)*

[9] ASTM D3162-12, *Standard Test Method for Carbon Monoxide in the Atmosphere (Continuous Measurement by Nondispersive Infrared Spectrometry)*

[10] ASTM D3824-12, *Standard Test Methods for Continuous Measurement of Oxides of Nitrogen in the Ambient or Workplace Atmosphere by the Chemiluminescent Method*

[11] ASTM D6522-11, *Standard Test Method for Determination of Nitrogen Oxides, Carbon Monoxide, and Oxygen Concentrations in Emissions from Natural Gas-Fired Reciprocating Engines, Combustion Turbines, Boilers, and Process Heaters Using Portable Analyzers*

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