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Indoor air —

Part 24: Performance test for evaluating the reduction of volatile organic compound concentrations by sorptive building materials

Air intérieur —

Partie 24: Essai de performance pour l'évaluation de la réduction des concentrations en composés organiques volatils par des matériaux de construction sorptifs

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 146, *Air quality*, Subcommittee SC 6, *Indoor air*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

This second edition cancels and replaces the first edition (ISO 16000-24:2009), which has been technically revised. The main changes compared to the previous edition are as follows.

— The target chemical compounds subject to this document have been changed from "volatile organic compound (except formaldehyde)" to "volatile organic compound" specified in ISO 16000-6.

A list of all parts in the ISO 16000 series can be found on the ISO website.

Introduction

Sorptive building materials have been marketed in the form of sheet and board products for removing airborne pollutants via physical sorption or chemical reaction.

Harmonized test methods for evaluating sorptive effects are important for comparative assessment of the performance of sorptive building materials that are used for reducing levels of indoor air contaminants.

This document specifies a test method for evaluating the performance of sorptive building materials for reducing indoor air volatile organic compound (VOC) concentrations over time.

The performance of sorptive building materials is evaluated by measuring the area-specific reduction rate and the saturation mass per area and is affected by a number of factors. Specific test conditions are therefore defined in this document.

This document can be applied to most sorptive building materials used indoors and for VOCs (excluding formaldehyde).

This document is based on and is complementary to the test chamber method specified in ISO 16000-9.

Indoor air —

Part 24: Performance test for evaluating the reduction of volatile organic compound concentrations by sorptive building materials

1 Scope

This document specifies a general laboratory test method for evaluating the reduction in concentration of VOCs by sorptive building materials. This method applies to boards, wallpapers, carpets, paint products, and other building materials. The sorption of those target compound(s), i.e. VOCs, can be brought about by adsorption, absorption and chemisorption. The performance of the material, with respect to its ability to reduce the concentration of VOCs in indoor air, is evaluated by measuring area-specific reduction rate and saturation mass per area. The former directly indicates material performance with respect to VOC reduction at a point in time; the latter relates to the ability to maintain that performance.

This document is based on the test chamber method specified in ISO 16000-9.

NOTE Sampling, transport and storage of materials to be tested, and preparation of test specimens, are described in ISO 16000-11. Air sampling and analytical methods to determine VOCs are described in ISO 16000-6 and ISO 16017-1.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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*

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 16000-11, *Indoor air — Part 11: Determination of the emission of volatile organic compounds from building products and furnishing — Sampling, storage of samples and preparation of test specimens*

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*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
area-specific reduction rate
q_{ads}
mass of *target compound(s)* (3.14) sorbed per time unit per area at the specified elapsed time from the test start

3.2
breakthrough time
t_b
time at which the *target compound* (3.14) concentration in the air eluting from the sample tube reaches 0,5 % of the concentration in the supply air

3.3
degradation coefficient
ratio of the mass of *target compound(s)* (3.14) removed by the initial performance divided by the mass of the same compound(s) lost by deterioration

3.4
elapsed time
t_e
time from the start of test to the start of air sampling

Note 1 to entry: Elapsed time is expressed in hours or days.

3.5
equivalent ventilation rate per area

$q_{V,\,eq}$
increased clean air ventilation rate giving the same reduction in *target compound* (3.14) concentration as the building material

3.6
guideline concentration
corresponding threshold indoor air concentration *for target compound(s)* (3.14) as specified by the WHO or an appropriate national standards body

3.7
half-lifetime
time elapsed from the start of the test until the *target compound* (3.14) concentration reduction performance decreases to one-half of the initial concentration reduction performance

3.8
lifetime
t_{lt}
time period over which the product continues to reduce *target compound* (3.14) concentrations

Note 1 to entry: The lifetime is given in days or years.

Note 2 to entry: The lifetime is estimated from the *area-specific reduction rate* (3.1) and *sorption capacity* (3.12) measured by the sample tube test.

3.9
mass transfer coefficient
k_a
coefficient arising from the concentrations difference between the test specimen and ambient air over its surface

Note 1 to entry: Mass transfer coefficient is expressed in metres per hour.

3.10
recovery
measured mass of *target compound(s)* (3.14) in the air leaving the test chamber with no sample present conditioned over a given time period divided by the mass of target compound(s) added to the test chamber in the same time period

Note 1 to entry: The recovery is expressed as a percentage and provides information about the performance of the entire method.

3.11
saturation mass per area
ρ_{Aa}
theoretical maximum mass of *target compound(s)* (3.14) that could be removed per area of the sorptive material

Note 1 to entry: Saturation mass per area is expressed in micrograms per square metre. It corresponds to the *total mass per area of sorption* (3.16) at the *half-lifetime* (3.7) , or is extrapolated from the *sorption capacity* (3.12) derived from the test specified in Annex A.

3.12
sorption capacity
w_S
total mass of *target compound(s)* (3.14) sorbed at *breakthrough time* (3.2) per mass of sorbent

Note 1 to entry: Sorption capacity is expressed in micrograms per gram and is measured using the test specified in Annex A.

3.13
supply air concentration
ρ_S
mass concentration of *target compound(s)* (3.14) in the air for supply to the test chamber

3.14
target compound
volatile organic compound in indoor air

3.15
test chamber concentration
concentration of *target compound(s)* (3.14) measured at the outlet of a test chamber, derived by dividing the mass of the target compound(s) sampled at the outlet of the chamber by the volume of sampled air

3.16
total mass per area of sorption
ρ_A
integral over time of *area-specific reduction rate* (3.1) from the start of the test to the specified *elapsed time* (3.4) measured with the test chamber

Note 1 to entry: Total mass per area of sorption is expressed in micrograms per square metre.

3.17
air sampling period
period of time during which air is sampled from the outlet of the test chamber using sampling tubes or other devices

4 Symbols

Symbol	Meaning	Unit
A	surface area of test specimen	square metres
q_{ads}	area-specific reduction rate per time per area	micrograms per square metre per hour
$q_{V,a}$	air flow rate per area	cubic metres per square metre per hour
$q_{V,eq}$	equivalent ventilation rate per area	cubic metres per square metre per hour
k_a	mass transfer coefficient determined using water vapor	metres per hour
L	product loading factor	square metres per cubic metre
m	actual mass of test specimen in sample tube	grams
n	air change rate	changes per hour
q_c	air flow rate of test chamber	cubic metres per hour
q_s	air flow rate of sample tube	litres per minute
t_b	breakthrough time	minutes
t_e	elapsed time	hours or days
t_{lt}	lifetime of the pollutant-removing performance	hours or days or years
V	air volume of test chamber	cubic metres
w_s	sorption capacity measured by sample tube	micrograms per gram
ρ_A	mass of sorptive material per area (surface density)	grams per square metre
ρ_{Aa}	saturation mass per area	micrograms per square metre
ρ_{Ac}	total mass per area of sorption measured by chamber test	micrograms per square metre
$\rho_{in,\,t}$	concentration of target compound(s) at test chamber inlet at elapsed time t	micrograms per cubic metre
$\rho_{out,\,t}$	test chamber concentration at elapsed time t	micrograms per cubic metre
ρ_s	supply air concentration in sample tube	micrograms per cubic metre

5 Principle

The performance of a building material in reducing the concentration of target compound(s), i.e. VOCs, from the indoor air, is evaluated by monitoring the reduction of the concentration inside a test chamber containing a test specimen of that material. The test assesses both the initial performance of the material and how long that performance is maintained.

In this test method, target compound-spiked air is supplied into a test chamber. The spiked air should be prepared at approximately the guideline concentration level for target compound(s) in indoor air. Reference to the WHO or an appropriate national standards body can be made if this is clearly highlighted in the test report.

Performance is determined by monitoring the difference of the inlet and outlet concentration of the test chamber. Testing should be continued for the half-lifetime, i.e. until the concentration reduction performance of target compound(s) drops to half that at the start of the test under constant ventilation conditions. This test determines area-specific reduction rate, ρ_{ads}, and total mass per area of sorption, ρ_{Ac}, at the half-lifetime. The measured ρ_{Ac} at the half-lifetime is defined as the saturation mass per area, ρ_{Aa}.

If a test material has a long-lasting target compound reduction performance (e.g. more than 28 days) and the test might take too long a time, alternative methods specified in Annex A for determining ρ_{Aa} may be applied.

The performance of sorptive building materials is mainly determined by the concentration of target compound(s), the mass transfer coefficient of target compound(s) to the surface, and the sorption

characteristics of the building materials themselves (adsorption isotherm, diffusion resistance, and so on). Therefore, the performance test method shall specify both the concentration of target compound(s) and the mass transfer coefficient associated with the sorptive building materials.

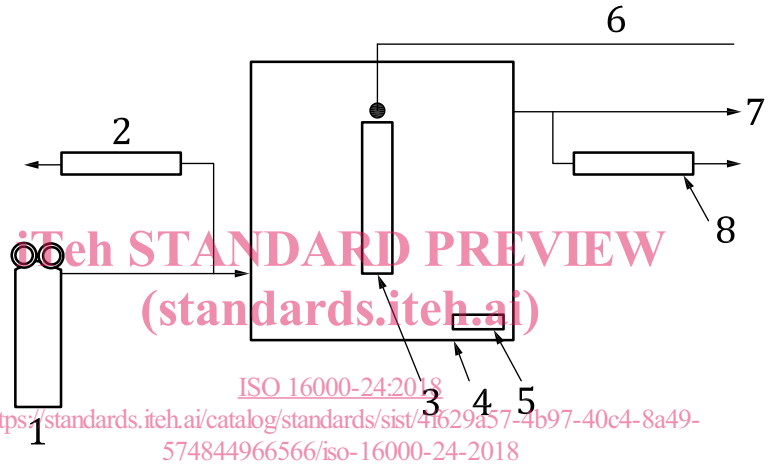
A re-emission test should be conducted following the test for evaluating concentration reduction performance, the procedure for which is described in 11.3.1.

NOTE The long-term target compound reduction performance is represented by the saturation mass per area, ρ_{Aa}, and, if necessary, the lifetime of the pollutant-removing performance, t_{lt}, as the subsidiary index.

6 Apparatus and materials

The usual laboratory apparatus and, in particular, the following.

6.1 Test chamber, complying with relevant specifications and requirements of ISO 16000-9 (see Figure 1). No air shall be allowed to circulate from the outlet back to the inlet.



Key

1 target compound(s) in spiked air (6.3)
2 air sampling device (6.6)
3 test specimen
4 test chamber (6.1)
5 device to circulate air and control air velocity
6 temperature/humidity monitoring apparatus (6.4)
7 test chamber outlet
8 air sampling device (6.6)

Figure 1 — Outline of the test chamber system

6.2 Air purifier or cylinder of clean air, to ensure the supply air before being spiked with target compound(s) is as clean as possible, i.e. it shall not contain any contaminants at levels greater than the chamber background requirements.

6.3 Supply air spiked with target compound(s), created by applying a standard gas (with known target compound concentrations). Alternatively, use a stable source to generate air spiked with target compound(s) that can be to supplied to the test chamber at a constant concentration. The stability of the spiked concentration(s) shall be monitored.

The spiked concentration(s) should be determined at least twice (at the beginning and end of the test).

6.4 Temperature and humidity monitoring apparatus.

Temperature shall be maintained either by installing a test chamber in a place maintained at a required temperature, or by maintaining a required temperature in the chamber. Relative humidity shall be maintained at the required humidity of the supply air.