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**Fine ceramics (advanced ceramics,  
advanced technical ceramics) —  
Test method for air-purification  
performance of semiconducting  
photocatalytic materials by test  
chamber method under indoor  
lighting environment —**

**Part 1:  
Removal of formaldehyde**

*Céramiques techniques — Méthode d'essai pour mesurer les performances des matériaux photocatalytiques semiconducteurs pour purifier l'air selon la méthode de la chambre d'essai dans un environnement d'éclairage intérieur —*

*Partie 1: Élimination du formaldéhyde*



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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](http://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](http://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 meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword — Supplementary information](#).

The committee responsible for this document is ISO/TC 206, *Fine ceramics*.

ISO 18560 consists of the following parts, under the general title *Fine ceramics (advanced ceramics, advanced technical ceramics) — Test method for air-purification performance of semiconducting photocatalytic materials by test chamber method under indoor lighting environment*:

— *Part 1: Removal of formaldehyde*

# Fine ceramics (advanced ceramics, advanced technical ceramics) — Test method for air-purification performance of semiconducting photocatalytic materials by test chamber method under indoor lighting environment —

## Part 1: Removal of formaldehyde

### 1 Scope

This part of ISO 18560 specifies a test method for the determination of the air-purification performance of materials that contain an indoor-light-active photocatalyst or have indoor-light-active photocatalytic films on the surface, usually made from semiconducting metal oxides, such as titanium dioxide or other ceramic materials, by continuous exposure of a test piece to the model air pollutant under illumination with indoor light. Formaldehyde (HCHO) is chosen because it is a typical indoor air pollutant that causes the so-called sick building syndrome. This part of ISO 18560 is intended to evaluate the photocatalytic performance for building materials, such as boards, wallpapers. This part of ISO 18560 does not apply to powder or granular photocatalytic materials.

This test method is usually applicable to indoor-light-active photocatalytic materials produced for air purification. This method is not suitable for the determination of other performance attribute of photocatalytic materials, i.e. decomposition of water contaminants, self-cleaning, antifogging and antibacterial actions. This test method is based on ISO 16000-23 and is adjusted for the measurement of indoor-light-active photocatalytic materials.

**NOTE** Another test method for the determination of air-purification performance of photocatalytic materials by using formaldehyde is described in ISO 22197-4. The test methods comprising of ISO 22197 are prepared for evaluation of material-based air-purification performance under irradiation of ultraviolet light, while this part of ISO 18560 is intended for providing a direct index to the improvement of indoor air quality by the indoor-light-active photocatalytic materials under the simulated conditions. Approximate correlation between the results by ISO 22197-4 and this part of ISO 18560 has been confirmed.

### 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.

ISO 6353-3, *Reagents for chemical analysis — Part 3: Specifications — Second series*

ISO 14605, *Fine ceramics (advanced ceramics, advanced technical ceramics) — Light source for testing semiconducting photocatalytic materials used under indoor lighting environment*

ISO 16000-3, *Indoor air — Part 3: Determination of formaldehyde and other carbonyl compounds — 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/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*

### 3 Terms and definitions

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

**3.1  
photocatalyst**  
substance that performs one or more catalytic functions based on oxidation or reduction reactions under photoirradiation

Note 1 to entry: The functions include decomposition and removal of air and water contaminants, deodorization, antibacterial, self-cleaning and antifogging actions. A photocatalyst can also be used for light energy conversion.

**3.2  
indoor-light-active photocatalyst**  
*photocatalyst* (3.1) that functions under illumination with artificial light used for general lighting purposes

**3.3  
indoor lighting environment**  
illumination with artificial light source(s) used for general lighting purposes and excluding sunlight

**3.4  
indoor-light-active photocatalytic materials**  
materials in which or on which the *indoor-light-active photocatalyst* (3.2) is added by coating, impregnation, mixing, etc.

**3.5  
photocatalytic materials**  
materials in which or on which the *photocatalyst* (3.1) is added by coating, impregnation, mixing, etc.

**3.6  
zero-calibration gas**  
purified air that does not contain pollutants which affect the test and gas analysis

Note 1 to entry: The zero-calibration gas is supplied as a synthetic air in a gas cylinder. It can also be prepared from indoor air using a laboratory air purification system.

**3.7  
supply air spiked with formaldehyde**  
mixture of high purity air and formaldehyde of known concentration prepared from a standard gas or a *zero-calibration gas* (3.6), to be used for the performance test of a *photocatalytic material* (3.5)

**3.8  
air change rate**  
ratio of the volume of supply air admitted to the test chamber per hour and the free test chamber volume measured in identical units

**3.9  
air flow rate**  
air volume admitted to the test chamber per unit time

**3.10  
product loading factor**  
ratio of exposed surface area of the test specimen and the free test chamber volume

**3.11  
dark condition**  
test condition of no light illumination by the light source for testing and room lightings

**3.12****equivalent ventilation rate per area**

clean air ventilation rate that would be required to reduce the formaldehyde concentration by the same amount as produced per unit area of the *photocatalytic material* (3.5) when exposed to indoor light

**3.13****guideline concentration**

guideline indoor air concentration for formaldehyde as specified by the World Health Organization (WHO)

Note 1 to entry: The guideline indoor air concentration for formaldehyde specified by the WHO is 100 µg/m<sup>3</sup>. Reference to national standards is possible if this is clearly highlighted in the test report and test certificate.

**3.14****mass transfer coefficient**

diffusion rate constant of the formaldehyde flux driven by the concentration difference between the test specimen and ambient air over its surface

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

**3.15****recovery**

measured mass of formaldehyde in the air leaving the test chamber with no sample present conditioned over a given time period divided by the mass of formaldehyde 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.

**3.16****sampling time**

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

**3.17****supply air concentration**

mass concentration of formaldehyde in air for supply to the test chamber

**3.18****irradiation start**

time of starting irradiation of indoor light to the specimen

**3.19****elapsed time**

time from *irradiation start* (3.18) to the start of air sampling

**3.20****test chamber concentration**

concentration of formaldehyde measured at the outlet of a test chamber, derived by dividing the mass of the formaldehyde sampled at the outlet of the chamber by the volume of sampled air

**4 Symbols**

$\rho_{in, t}$  concentration of formaldehyde 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)

$\rho_{gl}$  guideline concentration (micrograms per cubic metre)

$k_a$  mass transfer coefficient determined using water vapour (metres per hour)

$L$	product loading factor (square metres per cubic metre)
$n$	air change rate (changes per hour)
$q_a$	area specific air flow rate (cubic metres per square metre per hour)
$q_c$	air flow rate of test chamber (cubic metres per hour)
$q_{eq}$	equivalent ventilation rate (cubic metres per square metre per hour)
$r$	removal rate (micrograms per square metre per hour)
$r_{gl}$	removal rate when test chamber concentration is equal to guideline concentration (micrograms per square metre per hour)
$t_e$	elapsed time (hours or days)
$V$	air volume of test chamber (cubic metres)
$A$	surface area of the test specimen exposed to illumination (square metres)

## 5 Principle

The test piece, placed in a test chamber, is activated by indoor light illumination, and adsorbs and oxidizes gas-phase formaldehyde to form carbon dioxide (CO<sub>2</sub>) and other oxidation products. The air purification performance is determined by monitoring the reduction in formaldehyde concentration of the air leaving the test chamber.

The method uses a supply air spiked with formaldehyde at approximately the same concentration as the WHO guideline level for formaldehyde in indoor air (100 µg/m<sup>3</sup>), see Reference [1]. Reference to national standards may be made if this is clearly stated in the test report and test certificates.

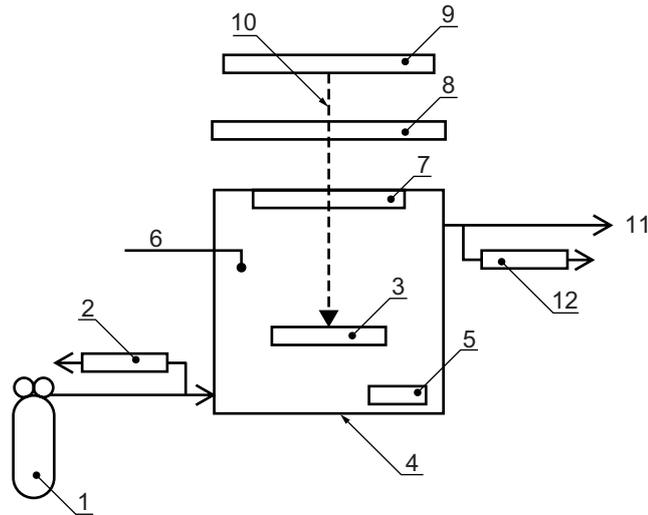
## 6 Apparatus

### 6.1 General

The apparatus necessary for measuring the removal performance of an indoor-light-active photocatalytic material in test consists of:

- test chamber;
- sealing material for test specimen;
- air purifier or other source of contamination-free air;
- supply air spiked with formaldehyde;
- temperature and humidity controls;
- air flow meter;
- light source;
- UV sharp cut-off filter;
- air sampling devices;
- analytical instruments.

See [Figure 1](#).



### Key

- 1 supply air spiked with formaldehyde
- 2 sampling device
- 3 test specimen
- 4 test chamber
- 5 device to circulate air and control of air velocity
- 6 temperature/humidity monitoring apparatus
- 7 glass window
- 8 UV sharp cut-off filter
- 9 light source
- 10 light irradiation
- 11 test chamber outlet
- 12 sampling device

Figure 1 — Schematic of the test system

## 6.2 Test chamber

A test chamber covered by this part of ISO 18560 shall comply with relevant specifications and requirements of ISO 16000-9 and have a glass window through which indoor-light irradiates a specimen. For low light-absorption over 380 nm wavelength, the window shall be constructed with silica glass or borosilicate glass. No air shall be allowed to circulate from the outlet back to the inlet.

## 6.3 Sealing material for test specimens

Aluminium foil or a tape covered with aluminium foil shall be used to cover the edges and the back of the test specimen.

## 6.4 Air purifier

Supply air before being spiked with formaldehyde shall be as clean as possible. In order to prevent a rise in background concentration, an air purifier shall be provided or clean cylinder air shall be used.

## 6.5 Supply air spiked with formaldehyde

Apply a standard gas (with known formaldehyde concentration) or a stable source like a formaldehyde solution as specified in ISO 6353-3, or paraformaldehyde, to generate air spiked with formaldehyde that can be supplied to the test chamber. Stability of formaldehyde concentration shall be monitored.

## 6.6 Temperature and humidity controls

The temperature shall be maintained either by installing the test chamber in a temperature controlled environment, such as a constant-temperature climate chamber, or by maintaining the required temperature in the chamber. Relative humidity shall be maintained in accordance with 7.2.1. Temperature and humidity controls of the supply air are described in ISO 16000-9.

## 6.7 Air flow meter

An air flow meter shall be installed at the inlet or the outlet of the test chamber to measure the air flow rate through the chamber.

## 6.8 Light source and UV sharp cut-off filter

The light source for indoor lighting environment is specified in ISO 14605. A halophosphate or triphosphor fluorescent lamp with a correlated colour temperature of between 3 800 K to 4 500 K shall be used. When a triphosphor fluorescent lamp is used for evaluating, the fluorescent lamp of the CIE 1974 general colour rendering index (Ra) defined by CIE 13.3 higher than 80 shall be selected. A UV sharp cut-off filter specified in ISO 14605 shall be used under UV cut-off condition. The test specimen shall be irradiated uniformly through the window by the light source. The light source that requires warming up shall be equipped with a shutter. The distance between the light source and the chamber shall be adjusted so that the illuminance on the test specimen surface is  $1\,000\text{ lx} \pm 50\text{ lx}$ . The irradiance along the length of the test specimen shall also be constant within  $\pm 5\%$ . The illuminance shall be measured with an illuminance meter which has been calibrated by a calibration laboratory. Reflection plate of luminaire and a shielding device of the reactor from external light are to show small or constant absorption in UV and indoor light. The reactor shall be shielded from external light if necessary.

## 6.9 Air sampling devices

The inlet and outlet air of the test chamber shall both be sampled.

If a duct or tube is used, it shall be as short as possible and maintained at the same air temperature as that in the test chamber. Such a duct or tube shall be made of a material with a very low sorption capacity, such as polytetrafluoroethylene.

The sum of sampling air flow rates shall be smaller than the air flow rate into the chamber. Sampling devices shall comply with the specifications of ISO 16000-3. When the air is sampled from the inlet, ensure the supply air flow rate remains constant.

A multiport sampling manifold may be used to provide flexibility for duplicate air sampling.

The exhaust from the test chamber should be ducted into a fume hood, ensuring that air spiked with formaldehyde and any chemicals emitted from the test material are isolated from the laboratory environment.

## 6.10 Device to circulate air and control of air velocity

The air in the test chamber shall be well circulated with a fan without adsorbing or emitting formaldehyde. The air velocity over the surface of the test specimen inside the test chamber shall be controlled as specified in 7.2.3.

## 6.11 Analytical instrument

A high performance liquid chromatograph (HPLC) shall be used as specified in ISO 16000-3.

## 7 Test conditions

### 7.1 General

The test conditions shall comply with 7.2 and 7.3. This test shall be conducted under atmospheric pressure conditions.

### 7.2 Test conditions of removal performance

#### 7.2.1 Temperature and relative humidity

Indoor-light-active photocatalytic building materials for use in Europe and America shall be tested in accordance with ISO 554 at a temperature of  $23\text{ °C} \pm 2\text{ °C}$  and relative humidity  $50\% \pm 5\%$  during the test.

Indoor-light-active photocatalytic building materials for use in Japan shall be tested at a temperature of  $28\text{ °C} \pm 2\text{ °C}$  and relative humidity  $50\% \pm 5\%$  during the test.

For indoor-light-active photocatalytic building materials with applications under other climatic conditions, alternative temperatures and air humidity conditions may be used, preferably as specified in ISO 554. State the conditions in the test report.

#### 7.2.2 Supply air quality and background concentration

The background concentration of the supply air to the test chamber and the air prior to spiking with formaldehyde shall be low enough not to interfere with the test. The total VOC (volatile organic compound) background concentration shall be lower than  $20\text{ }\mu\text{g}/\text{m}^3$ . The background concentration of formaldehyde shall be lower than  $2\text{ }\mu\text{g}/\text{m}^3$ . Purified water used for humidification shall not contain interfering VOCs that may affect the test.

#### 7.2.3 Mass transfer coefficient

The mass transfer coefficient in terms of ambient air velocity over the surface of the test specimen inside the test chamber shall be in the range of  $15\text{ m}/\text{h} \pm 3\text{ m}/\text{h}$  (equivalent to air velocity of  $0,25\text{ m}/\text{s} \pm 0,05\text{ m}/\text{s}$ ) when determined using water vapour.

NOTE 1 The mass transfer coefficient is analogous to convective heat transfer coefficient where geometry and boundary conditions are similar. The mass transfer coefficient can be estimated with a formulation that relates the mass transfer flux to a surface to the concentration differences across the boundary layer. For details concerning the mass transfer coefficient and its measurement method, see Reference [2].

NOTE 2 Removal performance depends on the mass transfer coefficient. Mass transfer coefficient depends on the indoor concentration of the substance, air flow and the surface area of the test specimen.

#### 7.2.4 Air change rate and product loading factor

The air change rate shall be kept constant at  $0,50/\text{h} \pm 0,05/\text{h}$ . The product loading factor shall be in the range of  $1,1\text{ m}^2/\text{m}^3 \pm 0,1\text{ m}^2/\text{m}^3$ .

For comparison of results from different test chambers, the air change rate,  $n$ , and the product loading factor,  $L$ , shall be the same for each chamber. The air change rate,  $n$ , and the product loading factor,  $L$ , may affect the removal rate,  $r$ .

NOTE The selection of area specific air flow rate affects the steady-state concentration of formaldehyde in the chamber air.

### 7.2.5 Supply air concentration

The concentration of formaldehyde vapour in the air supplied to the test chamber shall be approximately equal to the WHO guideline concentration. Other concentrations may be applied if relevant for the purpose of the test. This shall be stated explicitly in the test report.

### 7.2.6 Illuminance

The illuminance on the surface of the test specimen shall be kept constant at  $1\ 000\text{ lx} \pm 50\text{ lx}$ . Other illuminance may be applied if relevant for the purpose of the test. This shall be stated explicitly in the test report.

### 7.2.7 UV cut-off condition

For indoor-light-active photocatalytic building materials with applications under indoor lighting environment, the UV cut-off condition may be chosen from the following three conditions:

- a) no UV cut-off condition: no UV sharp cut-off filter will be used;
- b) under 380 nm cut-off condition: Type B UV sharp cut-off filter specified in ISO 14605 shall be used;
- c) under 400 nm cut-off condition: Type A UV sharp cut-off filter specified in ISO 14605 shall be used.

The selected UV cut-off condition shall be stated in the test report.

## 7.3 Factors affecting the removal performance (optional)

### 7.3.1 General

For evaluation of the effect of temperature, humidity and contaminants in air on the formaldehyde removal performance, modify each of these factors separately as described in [7.3.2](#) to [7.3.4](#).

### 7.3.2 Effects of temperature and humidity

The temperature in the test chamber should be set to  $18\text{ °C} \pm 1\text{ °C}$ ,  $23\text{ °C} \pm 1\text{ °C}$  and  $28\text{ °C} \pm 1\text{ °C}$ , with the relative humidity in the chamber as specified in [7.2.1](#) and the supply air concentration in the chamber set as specified in [7.2.5](#).

The relative humidity in the test chamber should be set to  $25\% \pm 5\%$ ,  $50\% \pm 5\%$  and  $75\% \pm 5\%$ , with the temperature in the chamber as specified in [7.2.1](#) and the supply air concentration in the chamber set as specified in [7.2.5](#).

### 7.3.3 Effects of formaldehyde supply air concentration

The formaldehyde supply air concentration should be set to twice the guideline concentration specified in [7.2.5](#), and then to one-half of the guideline concentration, with the chamber temperature and humidity set as specified in [7.2.1](#).

### 7.3.4 Effects of interfering gases

Various interfering gases are expected to exist in indoor environments. It is possible to measure their effect on the performance of testing materials in removing formaldehyde by measuring such performance while varying the concentration of each such interfering gas.

## 8 Verification of test conditions

### 8.1 Monitoring of test conditions

Temperature, relative humidity, and air flow rate shall be monitored and recorded continuously with instruments meeting the following accuracy specifications:

- temperature:  $\pm 1$  °C
- relative humidity:  $\pm 3$  %
- air flow rate:  $\pm 3$  %

Temperature and relative humidity of air may be measured in the outlet of the chamber provided that the point of measurement is constructed in a manner that ensures values identical to those inside the test chamber.

### 8.2 Air-tightness of test chamber

Air tightness of the test chamber should be checked regularly as specified in ISO 16000-9 either by pressure drop measurements, by comparison of simultaneous measurement of flow rates at the inlet and the outlet ports, or by measuring tracer gas dilution.

### 8.3 Air change rate in test chamber

The air change rate shall be regularly checked as specified in ISO 16000-9.

NOTE If the test is carried out in the outlet with an air flow meter that is not permanently installed, the back pressure introduced by the instrument can lower the flow rate through the test chamber.

### 8.4 Efficiency of the internal test chamber air mixing

Determine the efficiency of the air mixing as specified in ISO 16000-9.

### 8.5 Recovery

Recovery tests shall be performed in the test chamber by introducing supply air with the same formaldehyde concentration as to be used in the performance test and then comparing air measurement results at the outlet and inlet of the test chamber. The mean recovery shall be greater than 80 %. The results of the recovery test shall be reported (expected concentration versus concentration measured).

NOTE Sink effect, leakage or poor calibration can cause difficulties in meeting minimum requirements for the test.

## 9 Preparation of test chamber

The test chamber shall be cleaned in order to fulfil the requirements of 7.2.2. Cleaning can be done by washing the inner surface of the test chamber with a detergent followed by two separate rinsing with freshly distilled water. The test chamber is then dried and purged under test conditions. The test chamber can also be cleaned by thermal desorption.

For cleaning of the test chamber, an oven may be used to volatilize any aldehydes or VOCs on the internal wall of the test chamber. Alternative methods can be used instead of an oven.

## 10 Test specimen

### 10.1 Preparation of test specimen

A test specimen to be tested shall be prepared from the samples of the indoor-light-active photocatalytic material as specified in ISO 16000-11.

Seal the cut edges and the back of the specimen with aluminium foil or other sealing material.

### 10.2 Preparation for the test

The test specimen shall be soaked in distilled water for 1 h. The test specimen is then dried and purged at room conditions. The test specimen can also be dried under thermal condition. The temperature of the thermal condition should be less than 120 °C.

The test specimen shall be irradiated with an ultraviolet lamp for 12 h to 24 h in order to decompose residual organic matter on the test specimen. The UV irradiance on the surface of the test specimen shall be high enough to secure complete decomposition of organic matter (10 W/m<sup>2</sup> to 20 W/m<sup>2</sup>). In the treatment the test specimen shall be in a container which is airtight or in which zero calibration gas is supplied.

If the test specimen is not to be tested immediately after this treatment, it shall be kept in an airtight container in the dark.

## 11 Test methods

### 11.1 Background concentration and supply air spiked with formaldehyde

Prior to testing afresh, ventilate the test chamber for one day by running empty, and then measure and determine the background formaldehyde concentration of the empty test chamber.

The background concentration shall be low enough not to affect the test.

Then start flushing the test chamber with supply air spiked with formaldehyde. Allow at least five air exchanges before introducing the test specimen.

### 11.2 Placing the test specimen in the test chamber

Place the test specimen in the middle of the test chamber to ensure that air may uniformly flow over the indoor-light-active photocatalytic surface of the test specimen. Close the chamber.

Check the total air flow through the test chamber, and ensure that there is no air leakage from the test chamber.

### 11.3 Test under dark condition

To check the influence of the sorption performance of the test specimen, sample air from the chamber inlet and the chamber outlet under dark condition at one day after the placing of the test specimen. When the chamber formaldehyde concentration is less than 90 % of the supply air formaldehyde concentration, the test under dark condition shall be continued until the chamber formaldehyde concentration exceeds 90 % of the supply air formaldehyde concentration.

If it is clear that the indoor-light-active photocatalytic material to be tested adsorb the formaldehyde with the chemical sorption mechanism, the test under dark condition can be finished although the chamber formaldehyde concentration is less than 90 % of the supply air formaldehyde concentration at one day after the placing of the test specimen. This shall be stated explicitly in the test report.

### 11.4 Test for removal performance

Measure the quantity of formaldehyde removed from the test chamber air per unit of the test specimen exposed to the chamber air, under the measuring condition specified in 7.1.

Air samples from the chamber inlet and the chamber outlet in accordance with 11.6 shall be taken  $24\text{ h} \pm 2\text{ h}$ ,  $72\text{ h} \pm 6\text{ h}$ , and  $168\text{ h} \pm 14\text{ h}$  after the irradiation start. Additional air samples may be collected. Duplicate sampling is recommended.

Other time intervals may be selected according to the purpose of the test. If data on long-term performance of the testing material is required, air sampling shall be done over 7 days after the irradiation start in any case.

If VOCs and other chemical compounds are emitted from the testing material, measure their emission rates as specified in ISO 16000-3, ISO 16000-6, and ISO 16000-9.

### 11.5 Factors affecting the removal performance

The effect of each environmental factor may be measured by varying the value of only one factor at a time against those conditions used for the measurement of the removal performance in 11.4. The measuring conditions shall be as specified in 7.2.

### 11.6 Air sampling

A tube filled with DNPH (dinitrophenylhydrazine) as specified in ISO 16000-3 shall be used for air sampling for the determination of formaldehyde concentration.

## 12 Determination of formaldehyde

Elute the DNPH derivatives of formaldehyde from the DNPH tube and analyse as specified in ISO 16000-3.

## 13 Calculation and expression of results

Measure the concentrations at the inlet and outlet of the chamber. From the air flow rate in the chamber and the surface area of the test specimen, calculate the removal rate,  $r$ , using Formula (1):

$$r = (\rho_{in,t} - \rho_{out,t}) \times q_c / A \quad (1)$$

where

$r$  is the removal rate per unit time per unit area;

$\rho_{in,t}$  is the concentration of formaldehyde at test chamber inlet at elapsed time,  $t_e$ ;

$\rho_{out,t}$  is the test chamber concentration at elapsed time,  $t_e$ ;

$q_c$  is the air flow rate of test chamber;

$A$  is the surface area of test specimen.

Assuming that the chamber concentration is equal to the guideline concentration, calculate the removal rate at the guideline concentration,  $r_{gl}$ , using Formula (2):

$$r_{gl} = (\rho_{in,t} / \rho_{out,t} - 1) q_c \times \rho_{gl} / A \quad (2)$$

where

$r_{gl}$  is the removal rate per unit time per unit area at the guideline concentration;

$\rho_{gl}$  is the guideline concentration.

Assuming that the concentration falls due to increasing air flow rate of clean air, calculate the equivalent ventilation rate per area,  $q_{eq}$ , using Formula (3):

$$q_{eq} = (\rho_{in,t} / \rho_{out,t} - 1) q_c / A \quad (3)$$

## 14 Test report

The test report shall include at least the following information:

a) **test laboratory:**

- 1) name and address of the test laboratory,
- 2) name of the responsible person;

b) **sample description:**

- 1) type of the indoor-light-active photocatalytic materials (and brand name, if appropriate),
- 2) sample selection process (e.g. random),
- 3) product history (date of production, batch number, date of arrival to the test laboratory, date and time of unpacking, date and time of preparation of test specimen, etc.);

c) **test results:**

- 1) removal rate of formaldehyde, removal rate of formaldehyde at the guideline concentration, the equivalent ventilation rate per area at the specified elapsed time,
- 2) supply air formaldehyde concentration, chamber formaldehyde concentration in the test under dark condition,

d) **test conditions:**

- 1) test chamber conditions (temperature, relative humidity, air change rate, mass transfer coefficient, supply air concentration spiked with formaldehyde, illuminance on the surface of the specimen),
- 2) surface area of the test specimen and loading factor,
- 3) whether the test specimen was sealed (and how) or not,
- 4) information on air sampling (sampling tube used, volume of air sampled, vapour sampling period from the irradiation start, the number of samplings, etc.);

e) **devices:**

information on the equipment and procedure (test chamber, sealing material or sealing box, formaldehyde-spiking technique, air purifier, temperature and humidity controls, air flow meter, light source, UV sharp cut-off filter, climate chamber, air sampling devices, analytical instrument, etc.);

**f) quality control:**

- 1) background concentration of formaldehyde,
- 2) recovery data of formaldehyde,
- 3) number of measurement,
- 4) result of each analysis of air sampled, if duplicate sampling was undertaken,
- 5) accuracy of temperature, relative humidity and air change rate,

**g) additional matters for testing materials such as paints, coatings, or plastering materials:**

- 1) number of the test specimens,
- 2) mass per unit area,
- 3) thickness,
- 4) other observations that may influence the test results (drying conditions, storage, preservation, moisture content, surface treatment),
- 5) applied mass per area, in grams per square metre,
- 6) applied area,
- 7) applied method.

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