



**SLOVENSKI STANDARD**  
**oSIST prEN 16846-1:2015**  
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**Fotokataliza - Metode preskušanja "po lotih" - 1. del: Merjenje učinkovitosti fotokatalitičnih naprav v aktivnem načinu za odpravljanje hlapnih organskih spojin (VOC) in vonjav iz notranjega zraka**

Photocatalysis - Batch mode test methods - Part 1: Measurement of efficiency of photocatalytic devices used for the elimination of VOC and odour in indoor air in active mode

Photokatalyse - Batch-Betrieb-Prüfverfahren - Teil 1: Messung der Effizienz photokatalytischer Geräte im aktiven Modus zur Beseitigung flüchtiger organischer Verbindungen (VOC) und von Geruch in der Raumluft

Photocatalyse - Méthodes d'essai par lots - Partie 1 : Mesure de l'efficacité des dispositifs photocatalytiques servant à l'élimination, en mode actif, des COV et des odeurs dans l'air intérieur

**Ta slovenski standard je istoveten z: prEN 16846-1**

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**Photocatalysis - Batch mode test methods - Part 1:  
Measurement of efficiency of photocatalytic devices used for the  
elimination of VOC and odour in indoor air in active mode**

Photocatalyse - Méthodes d'essai par lots - Partie 1 :  
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servant à l'élimination, en mode actif, des COV et des  
odeurs dans l'air intérieur

Photokatalyse - Batch-Betrieb-Prüfverfahren - Teil 1:  
Messung der Effizienz photokatalytischer Geräte im aktiven  
Modus zur Beseitigung flüchtiger organischer Verbindungen  
(VOC) und von Geruch in der Raumluft

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 386.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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EUROPEAN COMMITTEE FOR STANDARDIZATION  
COMITÉ EUROPÉEN DE NORMALISATION  
EUROPÄISCHES KOMITEE FÜR NORMUNG

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## Foreword

This document (prEN 16846-1:2015) has been prepared by Technical Committee CEN/TC 386 “Photocatalysis”, the secretariat of which is held by AFNOR.

This document is currently submitted to the CEN Enquiry.

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## prEN 16846-1:2015 (E)

### 1 Scope

This part of this European Standard describes the methodologies to be used in a laboratory air tight chamber to test prototype or commercial air cleaner systems with a maximum flow rate of 1,000 m<sup>3</sup>/h used for the indoor air remediation.

It applies to the treatment of atmospheres that are representative of the air inside buildings and workplaces.

This protocol applies solely to photocatalytic systems alone or to combined systems that include a photocatalytic function.

This photocatalytic function is demonstrated by verifying the mineralisation of model VOCs to form CO<sub>2</sub>.

### 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 13725, *Air quality - Determination of odour concentration by dynamic olfactometry*

EN ISO 16017-1:2000, *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 16017-1:2000)*

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 16000-4, *Indoor air — Part 4: Determination of formaldehyde — Diffusive 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 part, the following terms and definitions apply.

#### 3.1

##### **photocatalyst**

substance that performs one or more functions based on oxidation and reduction reactions under photoirradiation, including decomposition and removal of air and water contaminants, deodorization, and antibacterial, self-cleaning and antifogging actions

#### 3.2

##### **volatile organic compounds**

3 classes of volatile organic compounds defined by the WHO:

- Semi-volatile (SVOC): compounds with a boiling point between (240 °C to 260 °C) and (380 °C to 400 °C)
- Volatile (VOC): compounds with a boiling point between (50 °C to 100 °C) and (240 °C to 260 °C)
- Very volatile (VVOC): compounds with a boiling point below 0 °C and (50 °C to 100 °C)

Note 1 to entry In this document: VOC covers all three classes of VOC.

#### 3.3

##### **system**

commercial or prototype air cleaner system that includes at least one photocatalytic function with or without a fan function

**3.4****chamber blank**

analysis of the composition of the air inside the air tight chamber with no air cleaner system inside the chamber and after venting by taking sampling on special cartridge for VOC and aldehyde

**3.5****test blank**

analysis of the composition of the air inside the air tight chamber with an air cleaner system operating inside the chamber, but with no pollutant by taking sampling on special cartridge for VOC and aldehyde

**3.6****cartridge blank**

analysis of the sorbent cartridge prior to use for the analysis of reaction by-products

**3.7****TWA**

time-weighted average, measured or estimated over an 8-hour work schedule

**3.8****STEL**

ceiling value that should never be exceeded in an occupational environment. **Short-term exposure limit (STEL):** these values measured during a maximum period of 15 minutes. TLV (threshold limit value) replaced by STEL

**3.9****indoor air**

air inside a closed environment

**3.10****mineralisation of model VOCs**

oxidation of model VOCs to form CO<sub>2</sub>

**4 Principle**

The system is placed inside an air tight chamber and exposed to a model VOC mixture. Changes in pollutant concentrations due to operation of the system, as well as the production of CO<sub>2</sub> and the appearance of by-products, are measured against time.

**5 Apparatus**

Standard laboratory apparatus, in addition to the following elements:

**5.1 Air tight chamber**

Air tight chamber with a volume of at least one m<sup>3</sup> fitted with an air homogenising device with a nominal hourly flow rate (m<sup>3</sup>/h) 100 times greater than the volume of the chamber. The ratio between the system volume and the chamber volume shall be less than or equal to 0,10.

The chamber has sampling ports and throughputs for electrical connections.

The behaviour of the material used to build the chamber in relation to pollutants, UV radiation, sorption and degassing phenomena shall be known and controlled.

Examples of materials: glass, PMMA, polyethylene, PTFE, stainless steel, etc.

**5.2 Analysis apparatus:**

All apparatus used for continuous monitoring of the air composition inside the chamber in the concentration range specified in Clause 6 can be used with a detection limit at around 5 ppbv for the test conditions stated in 6.1.1, or at 10% of the initial concentration of the relevant pollutants as specified in 6.1.2.

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Analyses of reaction by-products are performed according to the methods adapted to the characterisation of the indoor air quality. Reference will be made to the following standards, ISO 16000-3 and ISO 16000-6; EN ISO 16017-1:2000 (Annex B: Description of a few sorbents, see also Annexes C, D and E of EN ISO 16017-1:2000).

Temperature and relative humidity are analysed on line by appropriate analysers.

**6 Test performance****6.1 Pollutants and concentrations****6.1.1 General**

There are two possible concentration ranges depending on the outcome of the test.

For the cleaning of indoor air, the test is carried out in the range ppbv to ppmv.

Where the issue is directly related to the exposure of workers, the concentration will be related to the TWA and TLV/STEL of the relevant products.

**6.1.2 Indoor air****6.1.2.1 General**

The standard requires the use of the following mixture: (pollutants representative of the chemical families found in the indoor air pollution):

**6.1.2.2 Acetone, acetaldehyde, heptane, toluene and formaldehyde**

The test is to be run on both concentrations: [SIST EN 16846-1:2017](https://standards.iteh.ai/catalog/standards/sist/fa0d96ab-016b-4cdd-8867-6d74e63/sist-en-16846-1-2017)

— test with search for reaction by-products: <https://standards.iteh.ai/catalog/standards/sist/fa0d96ab-016b-4cdd-8867-6d74e63/sist-en-16846-1-2017>

50/ ppbv ± 25 % per compound at 22 °C 1P<sub>atm</sub>

— test used to demonstrate the photocatalytic activity with monitoring of the mineralisation of VOCs into CO<sub>2</sub>:

1000 ppbv ± 10% per compound at 22 °C 1P<sub>atm</sub>. (According to the present state of knowledge of analytical techniques, this test is the only means of monitoring the conversion into CO<sub>2</sub> against ambient concentration)

**6.1.3 Industrial issue and challenge**

Concentrations and pollutants will be chosen to reflect the issues and challenges currently facing the industrial sector. VOCs will undergo compound-by-compound analysis (e.g. by gas chromatography).

**6.2 Validation of the chamber**

The chamber is validated by measuring its leak tightness via its leakage rate or inert gas or by pollutant mixture disappearance.

It is necessary to check that the air homogenising fan does not generate VOCs.

The amount of VOCs released by the chamber prior to the test and captured on sorbent cartridges shall be less than 5 ppbv/compounds and less than 50 ppbv for the sum.

It is recommended that the chamber be validated by injecting the reaction mixture into the chamber with no system present and monitoring its behaviour during an 8-hour period with the air homogenising fan switched on.

Measured losses shall be less than 10% of the initial concentration during this period.



The chamber shall be validated following each use of a new pollutant.

### 6.3 Test conditions

Initial test conditions are as follows: chamber temperature ( $22 \pm 2$ ) °C, and relative humidity in the chamber of ( $50 \pm 5$ )%.

NOTE The humidity level in the chamber is not regulated during the test. Temperature (T °C) and relative humidity (% RH) are recorded continuously.

Before running any test, the chamber, with the system in operation, is flushed/vented with clean humidified air or with any other process that guarantees the RH conditions and blank quality specified below.

The chamber is considered to be clean when the compounds to be analysed are not detected by the analysis system run prior injecting the pollutants (examples in Annexes B and C).

For industrial-sector issues, the total measured VOC concentration shall be less than 5% of the VOCs injected into the chamber.

### 6.4 Test procedure

The system is placed in the centre of the chamber which is then flushed/vented with clean humidified air or with any other process that guarantees the RH conditions and blank quality specified in 6.3 for a period of one night.

The system is switched on during venting of the chamber in order to make sure that the system has been cleaned with clean air before taking any measurement. The system is operated for a period of 2 h during which data on T°, RH and VOCs is recorded prior injecting the pollutants. The system is then switched off.

The analysis systems that continuously monitor VOCs and CO<sub>2</sub> are operating prior the injection of the pollutants and throughout the whole period of analysis.

### 6.5 Mineralisation test with continuous monitoring of CO<sub>2</sub> levels

The mixture at 1000 ppbv per compound is injected into the chamber.

Any technique for generating the test atmosphere in the range of concentrations specified in 6.1 can be used.

EXAMPLE A simple technique for generating a polluted atmosphere is to prepare the mixture using an analytical balance, and then, using a micro-syringe, to inject a precise volume of this mixture through a septum into a glass weighing scoop making sure there is no contact with the materials making up the chamber.

The air is homogenised by the external fan.

Once the air has been homogenised, this homogenising fan is switched off and the system is switched on.

NOTE It may be difficult to homogenise the mixture with certain systems, such as those that contain activated carbon for example. In this case, it will be necessary to determine the time required to homogenise the mixture in the empty chamber and then take this time as the reference for starting up the system.

The test is run until 90% of VOCs are removed, with a maximum test time of 24 h.

### 6.6 Analysis of reaction by-products and ozone

A detection procedure targeting ozone and reaction by-products is run systematically for the mixture at 50 ppbv per compound (aldehydes, VOC, ozone).

By-products are analysed by the techniques used to characterise indoor air (see ISO 16000-4 and ISO 16000-6).

The following samples are taken:

NA.11 chamber blank prior to injection of the pollutants

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NA.2 After the mixture has been homogenised and the system switched on

T0	interval 0 to 15 min
T30	interval 30 to 45 min
T120	interval 120 to 135 min

T0 = system start-up

The times at which the samples are taken are adapted to fit system efficiency. For example in annex F, the time removal is less than 30 min. Times above have to be change.

The total sample volume shall not exceed 5 % of the volume of the chamber.

Should it prove necessary to take several samples simultaneously, these samples shall be taken at separate sampling points. Use of the Y distribution pattern is prohibited.

Ozone is measured by a specific probe.

Reaction by-products for high concentrations (> ppmv) (industrial environment) will be sought if the investigation concerns occupational exposure to chemicals.

## 6.7 Olfactive efficiency of the system

The system's ability to eliminate odours may be studied by taking a sample at the beginning (following injection of the pollutants and homogenising) and end of the test.

These samples are analysed by dynamic olfactometry in accordance with EN 13725.

## 7 Test report

The test report shall include at least the following information:

- Purpose of the investigation: information supplied by the person requesting the investigation;
- Methodology: reference to the standard, volume of the chamber, analysis techniques used, pollutant generation, etc.;
- Results:
  - plot of the behaviour of pollutants and CO<sub>2</sub> against time (ppbv and/or µg/m<sup>3</sup>); and a comparison graph between the CO<sub>2</sub> produced and the CO<sub>2</sub> expected from the VOC degradation;
  - plot of the development of T °C and % RH against time;
  - table of identified by-products (5 ppbv after subtracting the blank). This table shall have 3 columns: chamber blank, sample, sample minus the blank (the cartridge blank should be taken into account);
  - % mineralisation at the end of the test; calculated from the CO<sub>2</sub> produced against the expected CO<sub>2</sub> concentration.
  - plot of the behaviour of ozone against time;
  - all test observations, such as changes over time in temperature and % RH outside the limits set by the standard;
  - apparatus quantification and detection limits.

CADR Clean Air Delivery Rate calculated at low concentration test. All chemical concentrations shall be express as mg of C/m<sup>3</sup> and time in hours.

$$L_n \left( \frac{C}{C_0} \right) = - \left( k_n + \frac{CADR}{V} \right) t \quad \text{with } k_n = 0$$

$C$ : chemical concentration at time  $t$  (mg C/m<sup>3</sup>)

$C_0$ : chemical concentration at time  $t_0$

$V$ : volume of the test chamber (m<sup>3</sup>)

$t$ : time (h)

$CADR$  (m<sup>3</sup>/h)

$k_n$ : constant obtained from the blank test = 0 if no adsorption/leak are present.

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