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Indoor air —

Part 36: Standard method for assessing the reduction rate of culturable airborne bacteria by air purifiers using a test chamber

Air intérieur —

Partie 36: Méthode normalisée d'évaluation du taux d'abattement de bactéries cultivables aéroportées par des purificateurs d'air en utilisant une chambre d'essai

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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 of 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 www.iso.org/iso/foreword.html.

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

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

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 corrected version of ISO 16000-36:2018 incorporates the following corrections:

— In 6.3, the values $1{,}0 \times 10^3$ to $3{,}5 \times 10^3$ have been changed to $1{,}0 \times 10^9$ to $9{,}0 \times 10^9$;

— In 7.2.5, the values $1{,}0 \times 10^3$ and $3{,}2 \times 10^3$ have been changed to $1{,}0 \times 10^4$ and $3{,}2 \times 10^4$;

— In 8.2, the values $1{,}0 \times 10^3$ to $3{,}2 \times 10^3$ have been changed to $1{,}0 \times 10^4$ to $3{,}2 \times 10^4$.

Introduction

An indoor microbial environment is important to the health of occupants, particularly with regard to increased time spent indoors.

Air purifiers are used to reduce the concentration of microorganisms in indoor air.

The efficiency of such air purifiers to reduce airborne microorganisms can be investigated in test chambers at constant temperature and relative air humidity.

Indoor air —

Part 36: Standard method for assessing the reduction rate of culturable airborne bacteria by air purifiers using a test chamber

WARNING — The test given in this document shall be performed by expert staff trained and certified to handle microorganism-related techniques. The test bacterium *Staphylococcus aureus* is a facultative pathogen for human and animals. National and international safety procedures for working with infectious biomaterials shall be followed to prevent any contamination of apparatus, working place or environment. The examination and preparation of the cultures should be carried out in a microbiological safety cabinet class II.

1 Scope

This document specifies a method to evaluate the capacity of air purifiers to reduce the concentration of airborne culturable bacteria.

The test is applicable to air purifiers commonly used in single room spaces.

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 3696, *Water for analytical laboratory use — Specification and test methods*

ISO 16000-9:2006, *Indoor air — Part 9: Determination of the emission of volatile organic compounds from building products and furnishing — Emission test chamber method*

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 http://www.electropedia.org/

3.1
air purifier
electrically-powered device that is basically built of a fan and a set of components possessing the ability to capture and/or (partially or totally) destroy air pollutants

3.2
colony forming unit
cfu
unit by which the number of culturable *bacteria* (3.3) is expressed

[SOURCE: EN 13098:2000, modified]

3.3
bacteria
procaryotic, single-celled, microscopic organism with peptidoglycan cell wall

3.4
background concentration
concentration of culturable airborne *bacteria* (3.3) inside the test chamber prior to testing

3.5
natural decay rate
reduction rate of culturable *bacteria* (3.3), which is measured by comparing the concentration of bacteria immediately after nebulizing a bacterial suspension inside the chamber with the concentration counted after a defined time (testing time) without running the *air purifier* (3.1)

Note 1 to entry: Natural decay rate is expressed in per cent.

3.6
bacterial reduction rate
reduction rate of culturable *bacteria* (3.3), which is measured by comparing the concentration of bacteria immediately after nebulizing a bacterial suspension inside the chamber with the concentration counted after a defined running time (testing time) of the *air purifier* (3.1)

Note 1 to entry: Bacterial reduction rate is expressed in per cent.

3.7
impaction
sampling of airborne culturable *bacteria* (3.3) by inertial separation on a solid agar surface

4 Principle

The efficiency of air purifiers is tested using nebulized bacterial suspensions inside a test chamber at constant temperature and relative air humidity. The efficiency is calculated by the reduction rate of culturable airborne bacteria in a defined period of time, considering homogeneity and natural decay rate of the bacteria.

5 Apparatus and materials

5.1 Apparatus

5.1.1 Test chamber.

The chamber shall be made from suitable material, i.e. one that emits minimal pollutant is corrosion proof, such as stainless steel. It shall maintain sufficient airtight capacity.

The volume of the chamber should reflect the later application of the air purifier. The minimum volume shall not be below be 8 m^3 and is typically between 15 m^3 and 30 m^3.

Install a HEPA filter unit for cleaning air by removing particles, an air conditioning unit to control the temperature and humidity, and a system to decontaminate the air inside the test chamber. Particularly for larger test chambers, a fan is needed for homogenous distribution of the bacteria.

The test environment shall be kept clean and free from microbial contamination. It shall have a suitable environmental control system to maintain a constant temperature and humidity. To achieve this, the test chamber should include the following:

— a system capable of removing contamination and maintaining aseptic condition inside the chamber, such as an UV lamp;

— a facility to transfer items into and out of the chamber without cross-contamination (this can include a special system, such as a glove box);

— a facility to control power inside the chamber from outside;

— a facility to generate an aerosol of test bacteria inside the chamber and to ensure its homogeneity (this can be achieved by using a spray inlet through which bacteria are nebulised connected to a spray nozzle in the chamber, with a fan to ensure homogeneous distribution of the bacteria inside the chamber);

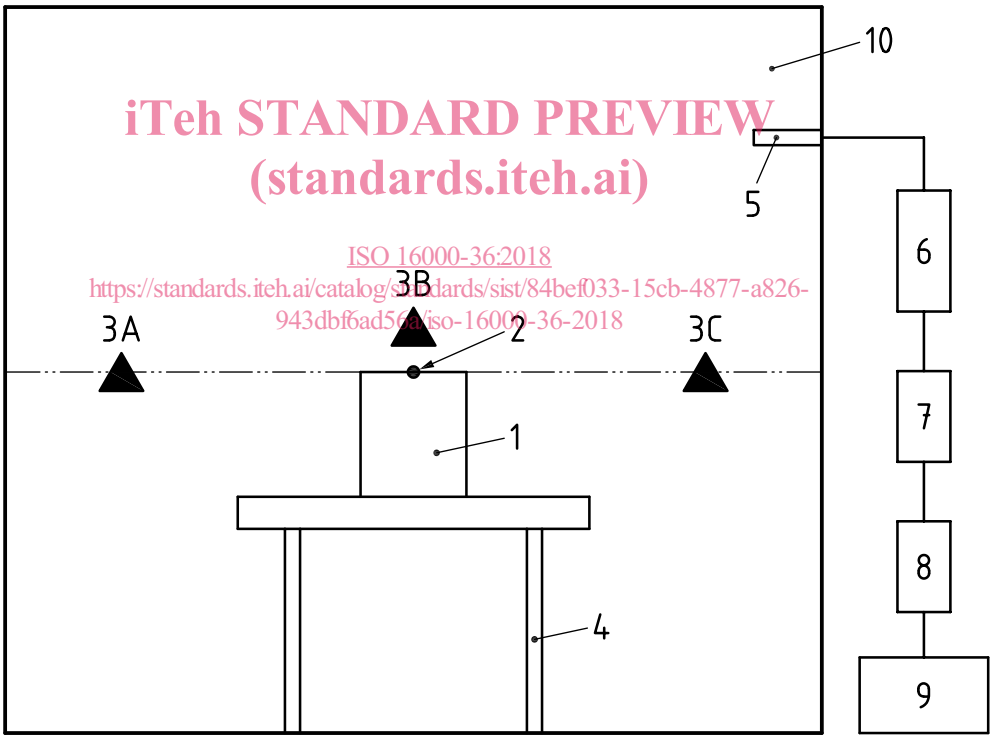
— an air conditioning system inside the chamber capable of controlling temperature and relative humidity in a stable and precise manner; the air conditioning system shall be switched off during the test;

— a facility to use negative pressure air flow to flush the chamber post-testing;

— an indicator to display main environmental factors of the test, including flow rate, temperature and relative humidity;

— a filter to prevent contamination from the outside during ventilation.

A test system using a test chamber is shown in Figure 1.



Key

1	air purifier	6	dehumidifier
2	air intake of air purifier	7	nebulizer
3	3A, 3B, 3C position of impactors	8	filter (to supply clean air)
4	stand for the air purifier	9	pressure pump
5	the inlet of spray	10	test chamber

Figure 1 — Schematic diagram of test system using a test chamber

Example photos of a test chamber are given in Annex A.

In accordance with ISO 16000-9:2006, 8.1:

— the test temperature and acceptable range of variation shall be (23 ± 2) °C;

— the test humidity and acceptable range of variation shall be (50 ± 5) %.

In addition, the test may be performed under other conditions. These conditions shall be documented.

After each test, the interior space of the test chamber is decontaminated using an UV lamp, 70 % ethanol (5.1.12) or adopting other decontamination methods in order to prevent contamination after a test.

5.1.2 Nebulizer.

The nebulizer shall be capable of nebulizing culture medium into particles (0,05 µm to 5 µm) to produce, as far as possible, individual bacterial particles. It typically comprises a pump to generate a defined air pressure to nebulize, a clean air supplying unit and a dehumidifier to remove excess water from the generated culture medium.

5.1.3 Impactor for sampling of bacteria.

The impaction method described in this document is only applicable for relatively low concentrations of culturable bacteria and small chambers, e.g. 8 m^3.

The initial concentration shall be below the upper detection limit of the sampling method. For impaction with a 300 holes sampler and a sampling volume of 100 l or 50 l, the upper detection limit is approximately 1,6 × 10^4 cfu/m^3 or approximately 3,2 × 10^4 cfu/m^3, respectively (299 of 300 possible colonies).

5.1.4 Stand, to position the impactor at the sampling height needed.

5.1.5 Autoclave, thermostatically controlled at (121 ± 3) °C and a pressure of (103 ± 5) kPa.

5.1.6 Incubator, thermostatically controlled at (36 ± 2) °C.

5.1.7 Deep freezer, thermostatically controlled at (–70 ± 10) °C.

5.1.8 Microbiological safety cabinet class II.

5.1.9 Balance, capable of weighing to ±0,01 g.

5.1.10 Inoculating loop, 4 mm in ring diameter, sterile.

5.1.11 Petri dishes, vented, sterile, 90 mm to 100 mm diameter.

5.1.12 Disinfectant, isopropanol or ethanol (70 % volume fraction).

5.1.13 pH-meter, capable of measuring to ±0,2 unit.

5.1.14 Timer.

5.2 Materials

5.2.1 Test bacteria

5.2.1.1 *Staphylococcus aureus* ATCC 6538

5.2.1.2 *Micrococcus luteus* ATCC 10240

For specific questions, other bacteria may be used. All strains used shall be listed in the test report.

5.2.2 Culture media and reagents

5.2.2.1 General

For the preparation of culture media and reagents, use ingredients of uniform quality and chemicals of analytical grade. Prepare culture media with distilled or deionized water equivalent to ISO 3696 quality 3 and free from bacterial growth inhibiting substances. Alternatively, use complete media and follow strictly the manufacturer's instructions.

5.2.2.2 Nutrient broth

Beef extract	3,0 g
Peptone	10,0 g
Sodium chloride	5,0 g
Water	1 000 ml

Dissolve ingredients in 1 000 ml of distilled or deionized water. Adjust pH with sodium hydroxide or hydrochloric acid. The final pH should correspond to 7,0 to 7,2 at 25 °C. Sterilize by autoclaving at (121 ± 3) °C for 15 min. Store at (5 ± 3) °C for not longer than one month.

5.2.2.3 Nutrient agar

Beef extract	3,0 g
Peptone	10,0 g
Sodium chloride	5,0 g
Water	1 000 ml
Agar	15,0 g

Dissolve ingredients in 1 000 ml of distilled or deionized water by heating. Adjust the pH with sodium hydroxide or hydrochloric acid. The final pH should correspond to 7,0 to 7,2 at 25 °C. Sterilize by autoclaving at (121 ± 3) °C for 15 min. Store at (5 ± 3) °C for not longer than one month.

5.2.2.4 Physiological saline solution

Sodium chloride	8,5 g
Water	1 000 ml

Prepare physiological saline solution by dissolving 8,5 g of sodium chloride in 1 000 ml of distilled or deionized water. Sterilize by autoclaving at (121 ± 3) °C for 20 min. Store for no longer than 12 months.