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Indoor air —

Part 43: Standard method for assessing the reduction rate of culturable airborne fungi by air purifiers using a test chamber

Air intérieur —

Partie 43: Méthode normalisée d'évaluation du taux d'abattement de champignons cultivables aéroportés par des purificateurs d'air en chambre d'essai

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Foreword

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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 document 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).

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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.

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 43:
Standard method for assessing the reduction rate of culturable airborne fungi by air purifiers using a test chamber

WARNING — The test given in this document shall be performed by persons who are familiar with techniques in connection with microorganisms. The test fungus *Penicillium roqueforti* is a common mould widespread in nature. It has been used for cheese making for a long time. However, it produces spores which can cause an allergic response in people who are sensitive to mould spores. Users of this document shall be aware of national and international safety procedures for working with allergic mould spores, to prevent any exposure in the test environment. The examination and preparation of the cultures should be carried out in a Class II Biological Safety Cabinet.

1 Scope

This document specifies a standard method to evaluate the capacity of air purifiers to reduce the concentration of airborne fungi and clean the air in the indoor environment.

The test is applicable to air purifiers which are commonly used in single room space.

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 16000-9:2024, *Indoor air — Part 9: Determination of the emission of volatile organic compounds from samples of 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 terminology 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
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 fungi is expressed

[SOURCE: ISO 16000-36:2018, 3.2, modified — “Bacteria” was changed to “fungi”.]

3.3
fungal background concentration
concentration of culturable fungi inside the test chamber prior to testing

3.4
natural decay rate
reduction rate of airborne culturable fungi, which is measured by comparing the concentration of fungi immediately after nebulizing a fungal 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 percent.

3.5
fungal reduction rate
reduction rate of airborne culturable fungi, which is measured by comparing the concentration of fungi immediately after nebulizing a fungal 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: Fungal reduction rate is expressed in percent.

3.6
impaction
sampling of airborne culturable fungi by inertial separation on a solid agar surface (culture medium or adhesive-coated slides)

Note 1 to entry: See ISO 16000-18.

Note 2 to entry: Sampling is carried out using either round-hole or slit impactors, for instance. As the air passes through the orifices, it is accelerated, and the particles are impacted on the medium located directly behind the nozzles as a result of their inertia, while the air flows around the culture medium and exits the sampler. Impaction samples are only suitable for direct analysis without further resuspension of the sample.

4 Principle

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

5 Apparatus and materials

5.1 Apparatus

5.1.1 Test chamber.

The static chamber shall be made from suitable material, i.e. one that emits minimal pollutant, is corrosion proof, such as stainless steel, and 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 8 m^3 and is typically between 15 m^3 and 30 m^3.

The inside of test chamber 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 a UV-C 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 on a rail system);

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

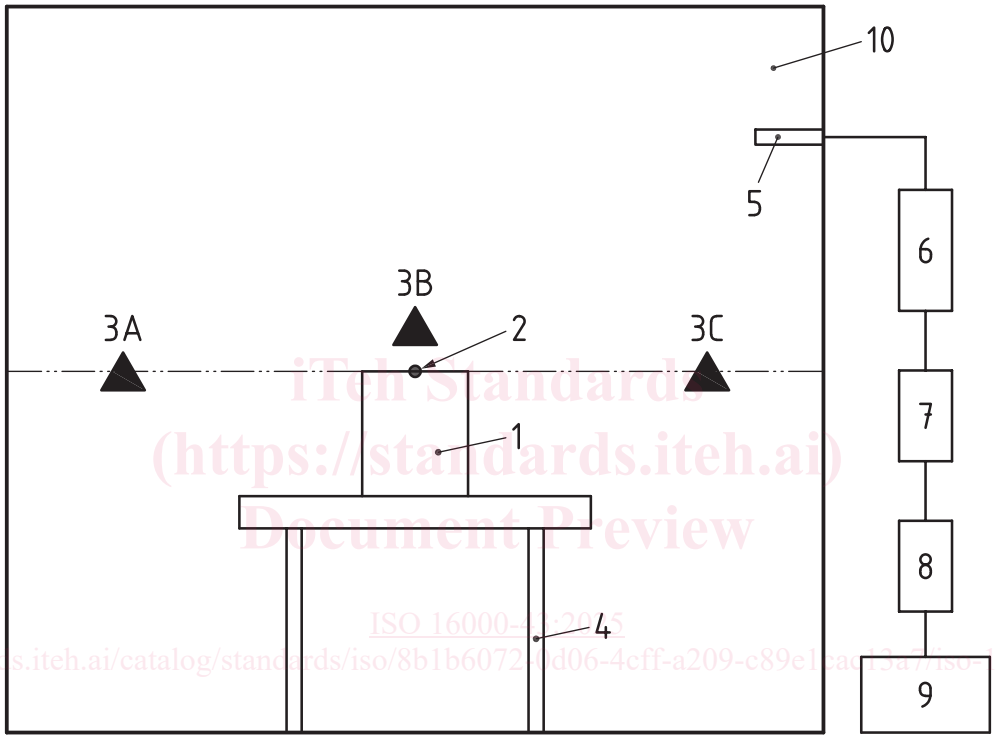
— a facility to generate an aerosol of test fungi inside the chamber and to ensure their homogeneity (this can be achieved by using a spray inlet, through which fungi are nebulized, connected to a spray nozzle in the chamber, with a fan to ensure homogeneous distribution of the fungi inside the chamber);

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



Key

1 air purifier
2 air intake of test unit
3 3A, 3B, 3C position of impactors
4 stand for the air purifier
5 inlet of spray
6 dehumidifier
7 nebulizer
8 filter (to supply clean air)
9 pressure pump
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 16000-9:2024, 8.1:

— the test temperature and acceptable range of variation shall be (23 ± 1) °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 a 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 the spore suspension into particles (0,05 µm to 5 µm) to produce, as far as possible, individual fungal particles. It typically comprises a pump to generate a certain air pressure to nebulize the spore suspension, a clean air supplying unit (HEPA filter) and a dehumidifier to remove excess from the generated spore suspension.

5.1.3 Impactor for sampling of fungi.

The impaction method described in this document is only applicable for relatively low concentrations of culturable fungi and small chambers with a volume of at least 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 50 l or 100 l at 100 l/min flow rate, the upper detection limit is approximately $1,6 \times 10^4$ cfu/m^3 or $3,2 \times 10^4$ cfu/m^3, respectively (299 of 300 possible colonies).

NOTE The detection limit is dependent on the sampling strain, which has different air flows and collection efficiency.

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 (25 ± 1) °C.

5.1.7 Cryogenic freezer, thermostatically controlled at (–70 ± 2) °C.

5.1.8 Class II Biological Safety Cabinet.

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.

5.1.15 Haemocytometer, a device used for counting red blood cells or fungal cells (spores).