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Indoor air —

Part 44:
Test method for measuring perceived indoor air quality for use in testing the performance of gas phase air cleaners

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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

There is an increased interest in the development of air cleaners removing gaseous pollutants. Such air cleaners are also called air purifiers. They have been marketed for reducing concentrations of gaseous pollutants using different removal principles including among others physical and physicochemical sorption or oxidation (mineralization).

The performance of gas phase air cleaners can be evaluated by their removal efficiency defined by the ratio of concentration of pollutants downstream and upstream an air cleaner in the case of single pass efficiency. Removal efficiency can also be obtained by determining the change of concentration in a room where an air cleaner is in operation. Removal efficiency is consequently used to calculate clean air delivery rate i.e. the equivalent airflow delivered by an air cleaner that does not contain pollutants that were removed by an air cleaner (unpolluted air).

The removal efficiency is usually determined using a single pollutant or a mixture of up to a few pollutants thus not capturing the entire spectrum of pollutants present. For this purpose, sensory assessment of air quality made by human subjects can be made. The ratings of air quality as perceived by people are not normally used (seldom) to assess the removal efficiency of air cleaners although, based on them, ventilation requirements prescribed by standards in many parts of the world have been determined. Because measurements of chemical compounds will seldom capture all pollutants and because no models exist to describe how they will be perceived by building occupants, examining the effect of the air quality of an air cleaner as perceived by humans [so-called perceived air quality (PAQ)] seems relevant and should be considered as a supplementary method to chemical measurements.

There are different methods used to determine PAQ. The two most frequently used are the assessments of odour intensity of the air and acceptability of air quality; the latter can be used to determine the percentage of dissatisfied people. The measurements are made by human subjects (sensory panels) who use their olfactory sense to determine PAQ. Specially trained subjects (so-called trained panels) and untrained subjects (so-called untrained panels) can be used.

Historically, when ventilation requirements were determined in the 1930s by Yaglou and his colleagues, odour intensity was used to determine PAQ based on which ventilation requirements were prescribed. Yaglou's results were subsequently used in standards and handbooks in many parts of the world have been fundamentally based on his work. In the later research in the 1980s among others by Fanger and his colleagues, the ratings of acceptability were used to describe PAQ and ventilation requirements prescribed in the standards were subsequently revised.

Considering the above, there is a need for a standard to assess the performance of gas phase air cleaners based on sensory ratings of air quality so that it can be compatible with the current ventilation standards. This document describes a test method that can be used to evaluate the performance of air cleaners that primarily remove gaseous pollutants from the air based on the ratings of PAQ.

Indoor air —

Part 44:
Test method for measuring perceived indoor air quality for use in testing the performance of gas phase air cleaners

1 Scope

This document specifies a laboratory test method for measuring perceived air quality using human subjects that can be used for assessing the performance of air cleaners removing gas-phase pollutants. The method describes the performance of gas-phase air cleaners with respect to removal of pollutants that can be sensed by human subjects.

The method has a reference to sensory tests specified in ISO 16000-28.

Air cleaners removing particles and aerosols (mechanical or electronic filters) can also remove pollutants responsible for sensory response. The method described in this document does not apply to testing of these air cleaners.

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 organic compounds (VVOC, VOC, SVOC) in indoor and test chamber air by active sampling on sorbent tubes, 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 16000-28, *Indoor air — Part 28: Determination of odour emissions from building products using test chambers*

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 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
acceptability
parameter used to describe indoor air quality as it is perceived by people

Note 1 to entry: Acceptability describes overall perception of the quality of air indoors taking into account intensity and hedonic character.

Note 2 to entry: Acceptability can be assessed with the dichotomous or continuous visual-analogue scale; the latter is frequently used. The end points are clearly acceptable and clearly unacceptable.

3.2
air cleaner
apparatus that reduces concentration of indoor pollutants using active or passive method

Note 1 to entry: An air cleaner in this document is understood as an electrically-powered device that is basically built of components having the ability to capture gas-phase pollutants and a fan drawing the air through it.

Note 2 to entry: An air cleaner is the device that can be installed either in a room or in a duct, or both.

3.3
odour intensity
parameter used to describe the intensity of odour caused by indoor pollutants as it is perceived by people

Note 1 to entry: Odour intensity is assessed using a continuous scale having end points “no odour” and “overpowering odour” and four intermediate equally distanced levels: “slight odour”, “moderate odour”, “strong odour” and “very strong odour”.

Note 2 to entry: Odour intensity can also be measured using other methods than described in Note 1 to entry. ISO 16000-28 provides a method using the perceived intensity with the unit pi. The method presented in Note 1 to entry and pi method are well correlated.

3.4
panel
group of people (assessors or subjects) performing sensory evaluation of *air quality* (3.6)

3.5
panel member
member of a *panel* (3.4) performing sensory evaluation of *air quality* (3.6)

3.6
perceived air quality
parameter used to describe the quality of indoor air as perceived by people and evaluated in terms of either *acceptability* (3.1) or *odour intensity* (3.3), or *both*

4 Principle

The aim of this document is to describe the method for measuring the perceived air quality indoors when gas-phase air cleaner(s) is(are) in operation. The perceived air quality is determined using subjective evaluations of either acceptability or odour intensity, or both. The air assessed by a panel is presented via a sniffing device (a funnel). The perceived air quality is used to determine the removal efficiency of an air cleaner(s). If the equivalent measurement accuracy can be guaranteed, the alternative method can be used where panel members directly enter the test chamber to perform sensory evaluations. Follow the method specified in Annex C.

The assessments are made in a test chamber having a general room volume size. The test method consists of two steps:

a) a sensory test without air cleaner(s), and

b) a sensory test with an air cleaner(s).

Before performing a sensory test using the described method, it must be documented that no compounds are present in the air that are toxic, carcinogenic or harmful to people performing sensory evaluations at the inhalation doses (concentration and exposure time) received during testing. Fulfilling this requirement will comply with general requirements set by the ethical committees worldwide.

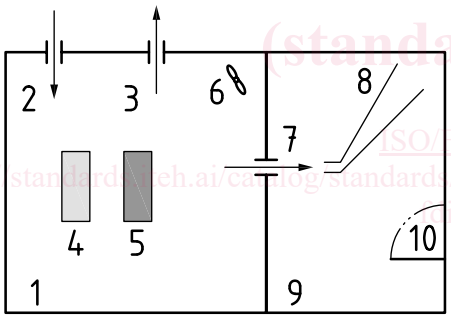
5 Apparatus, materials and sensory panel

5.1 Test chamber. A space large enough to room air cleaner, pollution sources and people - volunteer(s) staying inside for the purpose of emitting pollutants (a source of human bioeffluents) (see Figure 1) should be used as a test chamber. The room shall guarantee the same conditions as the test chamber specified in ISO 16000-9.

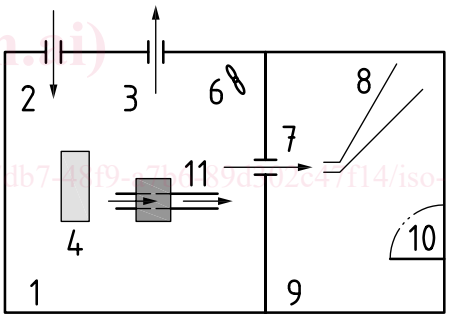
Test room shall have a suitable environmental control system to maintain a constant temperature and humidity, and provide ventilation with outdoor (unpolluted) air.

The room shall be kept clean and be characterized as low–polluting, i.e. the emissions of pollutants inside the room should be kept as low as possible to ensure proper background reference. The removal capacity of the test chamber for gaseous pollutants through e.g. adsorption should be sufficiently low not to compete with an air cleaner being tested.

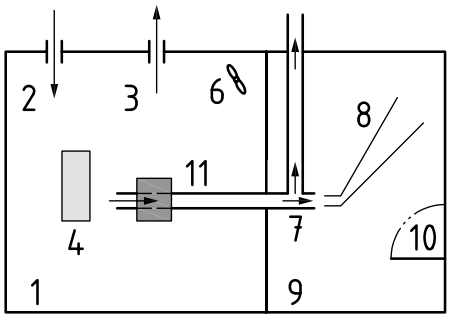
The test chamber shall be equipped with a fan ensuring that the air is well mixed within the entire volume thus complying with relevant specifications and requirements of ISO 16000-9. The mixing of the air shall be documented. No air shall be allowed to circulate from the air exhaust to air supply terminals.



a) Test room for a standalone air cleaner



b) Test room for a duct air cleaner



c) Test room for a duct air cleaner (single-pass condition)

Key

1	test chamber	7	tube or duct
2	clean and temperature/humidity conditioned air supply inlet	8	sniffing device, complying with relevant specifications and requirements of ISO 16000-28
3	exhaust outlet	9	front/anterior space in which human panel enter
4	emission source	10	doors where panel enters
5	an air cleaner	11	in duct air cleaner
6	mixing fan		

Figure 1 — Schematic diagram of a test room

5.2 Anterior space. Front/anterior space in which human panel enter shall guarantee the same temperature, relative humidity and background concentration conditions as the test chamber.

5.3 Temperature and humidity. Temperature in the chamber shall be maintained at 23 °C (±1 °C). Relative humidity in the chamber shall be maintained at 50 % (±10 %).

5.4 Air flow meter shall be installed at the inlet or the outlet of the test chamber to measure and monitor the air flow rate to or air exchange rate in the test chamber. Air flow meter should also be installed to measure the air flow rate from sniffing device. Air flow rate shall be regularly recorded.

5.5 Odour emission source(s) shall be building material(s) or product(s), permeation tube(s), and/or human volunteer(s) that steadily and constantly emit gaseous pollutants. They shall be placed/installed in the test chamber. Odour emission source(s) that result at least in the moderate odour intensity is desirable under the Step 1 test condition specified in 8.1.2.

5.6 Air cleaner. A stand-alone air cleaner shall be placed and operated in the test chamber. The in-duct air cleaners shall be installed in the duct with fan and then placed in the test chamber. When testing under single-pass conditions, the sniffing device should be installed in the duct after passing through the in-duct air cleaner.

5.7 Air sampling devices. Sampling devices used to sample the inlet and outlet air of the test chamber shall comply with the specifications of ISO 16000-3 and ISO 16000-6, respectively. When the air is sampled from the inlet, it shall be ensured that the supply air flow rate remains constant.

5.8 Analytical instrument. For determination of carbonyl compounds and volatile organic compounds (VOCs), a high-performance liquid chromatograph (HPLC) and/or a gas chromatograph (GC) shall be used as specified in ISO 16000-3, ISO 16000-6, and ISO 16017-1. Alternative devices with an equal or better accuracy can be used.

5.9 Sensory panel. The panel selection shall comply with the specifications of ISO 16000-28.

6 Test conditions

6.1 General

These test conditions apply at atmospheric pressure conditions. Temperature, relative humidity, background pollution levels, and air flows apply both for the test and anterior space.

6.2 Temperature and relative humidity

The temperature in the test chamber should be set to 23 °C (±1 °C), and relative humidity to 50 % (±10 %) when the tests are carried out. The actual temperature and humidity during any test shall be monitored and recorded and included in the test report. The measurements shall follow the protocol described in ISO 16000-9.

For air cleaners that have applications under specific climatic conditions varying significantly from the indicated set points, alternative temperature and air humidity conditions may be used, preferably as specified in ISO 554. These alternative conditions shall be monitored and recorded and included in the test report.

When it is important to examine whether the performance of an air cleaner depends on the changing levels of air temperature and relative humidity, the tests shall be extended to other temperatures and relative humidities than those indicated in this subclause.

6.3 Supply air quality and background concentration

The background concentration of pollutants in the air supplied to the test chamber shall be as low as not to interfere with the testing procedure. The same requirement applies to the background level (with no additional pollution sources) in the test chamber. The levels carbonyl and VOCs in the background shall be determined prior to the tests. It is recommended that the total VOC concentration in the test room is lower than 20 µg/m^3, while the concentration of each carbonyl compound and VOC lower than 2 µg/m^3 as specified in ISO 16000-9. Water used for humidification shall be purified and shall not to contain VOCs that can affect the testing procedure.

6.4 Air change rate

The air change rate should be kept constant at two levels of 0,50/h (±0,03/h) or 2,0/h (±0,12/h) in order to control odour concentration level in test chamber. The air change rate shall be regularly checked as specified in ISO 16000-9. Airflow meter shall be installed at the inlet or the outlet of the test chamber to perform measurements of the air flow rate or air change rate in the test chamber. Airflow meter should also be installed to measure the air flow rate from sniffing device. Airflow rate shall be monitored and recorded regularly.

The airflow rate at the sniffing device presenting the air to a panel member in anterior chamber and extracted from the space where air cleaner is tested shall be between 0,6 l/s to 1 l/s; it shall be constant for the duration of each test session as specified in ISO 16000-28. The air flow shall be regularly measured and reported. The system delivering the air for sensory assessments shall not be contaminated. An example of air flow condition is given in Annex B.

When the capped sniffing device is uncapped, the pressure in the test chamber can change and the flow rate will also change. Airflow rate from test chamber outlet and from niffing device shall be monitored and recorded regularly.

6.5 Panel members

The panel selection and assessment procedure of the acceptability and perceived intensity test shall comply with the specifications of ISO 16000-28. A minimum panel size is 15 untrained members as specified in ISO 16000-28. A panel of 25 members is needed to achieve the 90 % confidence interval, and to achieve the 95 % confidence interval, a panel of 30 to 40 members is needed.

6.6 Anterior space condition

Anterior chamber should be ventilated to keep the background concentration low enough not to interfere with the test. The temperature and relative humidity should be the same as in the test chamber. The changes in temperature and humidity during the test period should be monitored and recorded.