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Test methods for assessing the performance of gas-phase air cleaning media and devices for general ventilation —

Part 3: Classification system for GPACDs applied to treatment of outdoor air

Méthodes d'essai pour l'évaluation de la performance des médias et des dispositifs de filtration moléculaire pour la ventilation générale —

Partie 3: Système de classification pour les GPACD appliqués au traitement de l'air extérieur

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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).

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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 142, *Cleaning equipment for air and other gases*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 195, *Cleaning equipment for air and other gases,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

A list of all parts in the ISO 10121 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.

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Introduction

There is an increasing need for gas-phase filtration in general filtration applications. This demand can be expected to grow rapidly due to the increasing gaseous pollution problems in the world together with an increasing awareness that solutions to the problems are available in the form of filtration devices or, phrased more technically, gas-phase air cleaning devices (GPACD). The performance of devices relies to a large extent on the performance of the gas-phase air cleaning media (GPACM) incorporated in the device. The applications and device performance are often poorly understood by the users and suppliers of such media and devices. Media tests can be adequate to offer data for real applications if actual low concentrations (< 100 ppb) and longer exposure times (> weeks) can be used in the test, provided that the geometrical configuration, packing density and flow conditions of the small-scale test specimen are equal to those used in the real applications. Such tests are however not included in the scope of the ISO 10121 series.

ISO 10121-1 and ISO 10121-2 aim to provide laboratory test methods for GPACM and GPACD respectively. From the tests and reports produced, a person skilled in the field of molecular filtration can evaluate the performance of different products as well as comparing performance using benchmark tests for specific applications. To make these evaluations, a basic knowledge in chemistry, molecular filtration and the application at hand are necessary.

Persons not skilled in molecular filtration face challenges with increasing pollution. Annex A shows the annual average concentration of selected outdoor pollutants, the concentration differences of different urban and industrial settings as well as an example of ambient air quality guidelines. The air quality guideline is from WHO, where most countries have similar national threshold values. Due to this increasing pollution in urban areas, any building owner, facility management engineer, design engineers or maintenance personnel need to be able to evaluate GPACDs for general ventilation in buildings. Different standards classifying air filters for particle filtration (e.g. ASHRAE 52.2 and ISO 16890-1) have, together with many national standards, made a vast difference in facilitating the selection of air filters for particle filtration for general ventilation in buildings. Equivalent standards classifying molecular filtration devices, i.e. GPACDs, have not been available up to the publication of this document. This document addresses the specific case of outdoor air to buildings in cities and aim to be used in parallel with ISO 16890-1.

The ISO 10121 series consists of three parts.

— ISO 10121-1 covers three different media configurations and aims to provide a standardized interface between media suppliers and producers of air cleaning devices. It may also be used between media suppliers and end customers with regards to loose fill media properties.

— ISO 10121-2 aims to provide a standardized interface between suppliers of air cleaning devices and end customers seeking the most cost-efficient way to employ gas-phase filtration.

— ISO 10121-3 provides a classification system for the specific application of GPACDs in general, ventilation systems for cleaning of outdoor air polluted by local urban sources and/or long-range transboundary air pollution.

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Test methods for assessing the performance of gas-phase air cleaning media and devices for general ventilation —

Part 3: Classification system for GPACDs applied to treatment of outdoor air

1 Scope

This document establishes a classification system for GPACDs supplying single pass outdoor air to general ventilation systems using outdoor air polluted by local urban sources and/or long-distance pollution. The classification system is intended to aid in assessing molecular contamination in addition to the particulate contamination dealt with by ISO 16890-1.

This document specifies four reference pollutants, i.e. ozone, sulphur dioxide, nitrogen dioxide and toluene, used for the classification due to their relevance to the intended application. This document further specifies three duty levels that are assigned for each pollutant reflecting the typical performance range of devices intended for the application. Since selection of reference pollutants and duty levels are specific and unique to the intended application, all other applications are excluded. In particular, this document does not apply to GPACDs in recirculation applications and/or dealing with pollution from indoor sources as well as pharmaceutical, microelectronic, nuclear, homeland security and military applications.

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 10121-2:2013, *Test methods for assessing the performance of gas-phase air cleaning media and devices for general ventilation — Part 2: Gas-phase air cleaning devices (GPACD)*

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
adsorption
process in which the molecules of a *gas* (3.14) or vapour adhere by physical or chemical processes to the exposed surface of solid substances, both the outer surface and inner pore surface, with which they come into contact

[SOURCE: ISO 29464:2017, 3.5.7]

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3.2
adsorbate
molecular compound in gaseous or vapour phase that may be retained by an *adsorbent* (3.3) medium

[SOURCE: ISO 29464:2017, 3.5.3]

3.3
adsorbent
material having the ability to retain gaseous or vapour *contaminants* (3.10) on its surface by physical or chemical processes

[SOURCE: ISO 29464:2017, 3.5.4]

3.4
ambient pressure
absolute barometric pressure immediately outside the test rig

[SOURCE: ISO 29464:2017, 3.5.50, modified — The word "barometric" has been added.]

3.5
adsorbate capacity
m_s
maximum amount (mass or moles) of a selected *adsorbate* (3.2) that can be contained in GAPC medium or device under given test conditions and a specific end point (termination time)

Note 1 to entry: Capacity can also be negative during *desorption* (3.11).

[SOURCE: ISO 29464:2017, 3.5.12, modified — The symbol m_s and the words "maximum" and "a specific" have been added.]

3.6
challenge air stream
test *contaminant(s)* (3.10) of interest diluted to the specified *concentration(s)* (3.9) of the test prior to filtration

[SOURCE: ISO 29464:2017, 3.5.13]

3.7
challenge concentration
concentration (3.9) of the test *contaminant(s)* (3.10) of interest in the air stream prior to filtration [*challenge air stream* (3.6)]

[SOURCE: ISO 29464:2017, 3.5.14]

3.8
challenge compound
chemical compound that is being used as the *contaminant* (3.10) of interest for any given test

[SOURCE: ISO 29464:2017, 3.5.15]

3.9
concentration
C_n
quantity of one substance dispersed in a defined amount of another

Note 1 to entry: Indices "n" denote location.

[SOURCE: ISO 29464:2017, 3.1.7, modified — The symbol C_n and Note 1 to entry have been added.]

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3.10
contaminant
substance [solid, liquid or *gas* (3.14)] that negatively affects the intended use of a fluid

[SOURCE: ISO 29464:2017, 3.1.8, modified — The alternative term "pollutant" has been removed.]

3.11
desorption
process in which *adsorbate* (3.2) molecules leave the surface of the *adsorbent* (3.3) and re-enter the air stream

Note 1 to entry: Desorption is the opposite of *adsorption* (3.1).

[SOURCE: ISO 29464:2017, 3.5.21]

3.12
downstream
area or region into which fluid flows on leaving the *GPACD* (3.15)

[SOURCE: ISO 29464:2017, 3.1.11, modified — "GPACD" has been used instead of "test device".]

3.13
face velocity
volumetric air flow rate divided by the nominal *GPACD face area* (3.16)

Note 1 to entry: *GPACD* (3.15) face velocity is expressed in m/s.

[SOURCE: ISO 29464:2017, 3.1.15, modified — The alternative term "filter face velocity" has been removed; "GPACD face area" and "GPACD face velocity" have been used instead of "filter face area" and "filter face velocity".]

3.14
gas
substance whose vapour pressure is greater than the *ambient pressure* (3.4) at ambient temperature

[SOURCE: ISO 29464:2017, 3.1.28]

3.15
gas-phase air cleaning device
GPACD
assembly of a fixed size enabling the removal of specific gas- or vapour-phase *contaminants* (3.10)

Note 1 to entry: It is normally box shaped or fits into a box of dimensions between 290 mm × 290 mm × 290 mm up to approximately 610 mm × 610 mm × 610 mm or 2 ft × 2 ft × 2 ft.

[SOURCE: ISO 29464:2017, 3.5.32, modified — The box dimensions in note 1 to entry have been modified.]

3.16
GPACD face area
nominal cross-sectional area of the *GPACD* (3.15)

Note 1 to entry: For the purpose of standardizing measurements, the nominal area is calculated using 610 mm × 610 mm for a full-size filter, 610 mm × 305 mm for a half-size filter and 305 mm × 305 mm for a quarter size filter.

3.17
heavy duty
HD
duty level (specific dose) of a *contaminant* (3.10) that corresponds to a *removal efficiency* (3.29) versus dose performance for a *GPACD* (3.15) that is used in challenging environments (e.g. heavily polluted environments)

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3.18
initial dose
D_i
mass per *GPACD face area* (3.16) that reaches a *GPACD* (3.15) calculated from air flow in (volume per time), time, pollution *concentration* (3.9) (mass per volume) and GPACD face area during the test phase for determination of the *initial efficiency* (3.19)

3.19
initial efficiency
E_i
removal efficiency (3.29) of an unexposed filter or *GPACD* (3.15) calculated as soon as possible after the start of a test

Note 1 to entry: For gas-phase, this should be calculated as soon as a steady reading can be obtained.

3.20
integrated removal efficiency
E_Σ
numerically integrated fraction or percentage of a challenge *contaminant* (3.10) that is removed by a *GPACD* (3.15) over a specified time or dose period

3.21
light duty
LD
duty level (specific dose) of a *contaminant* (3.10) that corresponds to a *removal efficiency* (3.29) versus dose performance for a *GPACD* (3.15) that is used as an entry level solution, for low *concentrations* (3.9) or intermittent contamination episodes

3.22
medium duty
MD
duty level (specific dose) of a *contaminant* (3.10) that corresponds to a *removal efficiency* (3.29) versus dose performance for a *GPACD* (3.15) that is used for medium *concentrations* (3.9) of contamination

3.23
molecular contamination
contamination present in *gas* (3.14) or vapour phase in an air stream and excluding compounds in particulate (solid) phase regardless of their chemical nature

[SOURCE: ISO 29464:2017, 3.5.40]

3.24
normalised dose
D_N
mass per *GPACD face area* (3.16) that reaches a *GPACD* (3.15) calculated from air flow in (volume per time), time, pollution *concentration* (3.9) (mass per volume) and GPACD face area

3.25
normalised retentivity
R
measure of the ability of an *adsorbent* (3.3) or *GPACD* (3.15) to resist *desorption* (3.11) of an *adsorbate* (3.2) per *GPACD face area* (3.16)

Note 1 to entry: Computed as the residual capacity (fraction remaining) after purging the adsorbent with clean, conditioned air only, following challenge breakthrough and expressed per *GPACD face area* (3.16).

[SOURCE: ISO 29464:2017, 3.5.53, modified — "normalised" has been added in the term, the symbol *R* has been added, "per GPACD face area" has been added in the definition, "and expressed per GPACD face area" has been added in Note 1 to entry.]

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3.26
ppb(v)
parts per billion by volume
concentration (3.9) measure normally used to record ambient levels of outdoor pollution

Note 1 to entry: Units are mm^3/m^3.

[SOURCE: ISO 29464:2017, 3.5.43, modified — "parts per billion by volume" has been moved from the definition to the admitted term.]

3.27
ppm(v)
parts per million by volume
concentration (3.9) measure normally used to record pollution levels in, e.g. work place safety

Note 1 to entry: Units are cm^3/m^3 and ml/m^3.

[SOURCE: ISO 29464:2017, 3.5.44, modified — "parts per million by volume" has been moved from the definition to the admitted term.]

3.28
pressure drop
Δp
difference in absolute (static) pressure between two points in an airflow system

Note 1 to entry: In this document, pressure drop is measured between points upstream and *downstream* (3.12) of the *GPACD* (3.15).

[SOURCE: ISO 29464:2017, 3.1.36, modified — The alternative terms "resistance to air flow", "differential pressure" and "pressure differential" have been removed; the symbol Δp has been added; and "airflow system" has been used instead of "a system"; the original note 1 to entry has been replaced by a new one.]

3.29
removal efficiency
E
fraction or percentage of a challenge *contaminant* (3.10) that is retained by a GPAC medium or device at a given time

Note 1 to entry: Removal efficiency is also known simply as "efficiency".

[SOURCE: ISO 29464:2017, 3.5.26, modified — The symbol E has been added.]

3.30
residence time
relative time that an increment of fluid [or *contaminant* (3.10)] is within the boundaries of the medium volume

[SOURCE: ISO 29464:2017, 3.5.52, modified — Notes to entry have been removed.]

3.31
retentivity
m_r
measure of the ability of an *adsorbent* (3.3) or *GPACD* (3.15) to resist *desorption* (3.11) of an *adsorbate* (3.2)

Note 1 to entry: Computed as the residual capacity (fraction remaining) after purging the adsorbent with clean, conditioned air only, following challenge breakthrough.

[SOURCE: ISO 29464:2017, 3.5.53, modified — The symbol m_r has been added.]

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3.32
very light duty
vLD
removal efficiency (3.29) versus dose performance for a *GPACD* (3.15) that reaches less than 50 % efficiency at the *LD* (3.21) dose

4 Symbols and abbreviated terms

C_u	upstream concentration (ppb, ppm) measured at a position *X* mm before the device
C_d	downstream concentration (ppb, ppm) measured at a position *Y* mm after the device
E_i	initial removal efficiency (%) for the device measured at a low (< 1 ppm) challenge concentration during the initial efficiency test
E_0	initial removal efficiency (%) for the device measured at a high (> 1 ppm) challenge concentration during the challenge test
E_c	removal efficiency (%) for the device measured at the challenge concentration selected during the capacity test
E_{td}	efficiency recorded at stop time according to the classification level (%)
Q	flow used in test (normally the rated flow for the tested device) (m^3/h) measured at a position *Z* mm after the device, see ISO 10121-2
R	normalised retentivity (g/m^2)
v_f	face velocity (m/s) calculated from flow and cross-sectional area of device
T_u	temperature upstream (°C)
T_d	temperature downstream (°C)
φ_U	relative humidity upstream
φ_D	relative humidity downstream
D	dose (g)
ASHRAE	American Society of Heating Refrigerating and Air-conditioning Engineers
FID	flame ionization detector
PID	photo ionization detector
TVOC	total volatile organic compounds

NOTE TVOC is a common way to refer to a larger mix or organic pollutants present either indoors or outdoors.

5 Classification system for outdoor air

5.1 General

To express filtration performance in an easy to digest way for the target group of non-specialists, e.g. building and ventilation personnel, a classification using the following three measures shall be used:

a) the initial removal efficiency E_i of pollution at start;

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