DRAFT INTERNATIONAL STANDARD ISO/DIS 10121-1

ISO/TC 1**42** Secretariat: **UNI**

Voting begins on **2012-05-03** Voting terminates on **2012-10-03**

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

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

Part 1:
Gas-phase air cleaning media

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

Partie 1: Médias de filtration moléculaire (GPACM)

ICS 91.140.30

ISO/CEN PARALLEL PROCESSING

This draft has been developed within the International Organization for Standardization (ISO), and processed under the **ISO-lead** mode of collaboration as defined in the Vienna Agreement.

This draft is hereby submitted to the ISO member bodies and to the CEN member bodies for a parallel five-month enquiry.

Should this draft be accepted, a final draft, established on the basis of comments received, will be submitted to a parallel two-month approval vote in ISO and formal vote in CEN.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

Pour accélérer la distribution, le présent document est distribué tel qu'il est parvenu du secrétariat du comité. Le travail de rédaction et de composition de texte sera effectué au Secrétariat central de l'ISO au stade de publication.

Contents

Page

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 10121-1 was prepared by Technical Committee ISO/TC 142, *Cleaning equipment for air and other gases*.

ISO 10121 consists of the following parts, under the general title *Test methods for assessing the performance of gas-phase air cleaning media and devices for general ventilation*:

— *Part 1: Gas Phase Air Cleaning Media (GPACM)*

— *Part 2: Gas Phase Air Cleaning Devices (GPACD)*

Introduction

There is an increasing use and need for gas phase filtration in general filtration applications. This demand can be expected to increase rapidly due to the increasing 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 using adsorption for gas removal relies to a large extent on the performance of a gas phase air cleaning media (GPACM) incorporated in the device. Still applications, device performance and media performance are often poorly understood by the user and supplier of such media and devices. Media tests may also 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 this standard. This standard attempts to increase understanding and communication by supplying a more standardized interface between media suppliers, device suppliers and end users. At present standards exist for general ventilation in Japan[1] by JIS, Automotive filters[2] by ISO, in-duct sorptive media gas-phase air-cleaning devices by ASHRAE[3] and for adsorptive media by ASHRAE[4] and ASTM[5]. No international standard for general filtration exist today.

This DRAFT International Standard (part1) will provide methods, test equipment, data interpretation and reporting for three different types of gas phase air cleaning media (GPACM) intended for use in gas phase air cleaning devices (GPACD) for general ventilation applications.

In addition information is given in a number of annexes where:

— Annex A describes the normative validation procedure in detail in a tabulated form.

— Annex B gives a list of possible test gases, generation sources and suggests proper analysis equipment for common test gases

— Annex C describes the design of the test stand except the normative sample holder.

— Annex D describes the normative test setup and normative section of the test stand for the three different media configurations.

A general introduction to molecular filtration and molecular filtration testing can be found in the scientific literature.

This standard aims to provide laboratory test methods for media and devices which are used for removal of gas phase contaminants from air in general ventilation. The standard consists of two parts: the present part, 10121-1, covers three different media configurations and is targeted towards giving a standardized interface between media suppliers and producers of air cleaning devices. Part 1 may also be used between media suppliers and end customers with regards to loose fill media properties. Part 2, 10121-2 aims to give a standardized interface between suppliers of air cleaning devices and end customers seeking the best performing and most economical way to employ gas phase filtration.

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

Part 1:
Gas-phase air cleaning media

1 Scope

This standard aims to provide an objective laboratory test method, a suggested apparatus, normative test sections and normative tests for evaluation of three different gas phase air cleaning media (GPACM) or GPACM configurations for use in gas-phase air cleaning devices intended for general filtration applications. The standard is specifically intended for challenge testing and not for general material evaluation or pore system characterisation. The three different types of GPACM identified in this standard are GPACM-LF (particles of different shape and size intended for e.g. Loose Fill applications), GPACM-FL (FLat sheet fabric intended for e.g. flat one layer, pleated or bag type devices) and GPACM-TS (three dimensional structures that are many times thicker than flat sheet and e.g. used as finished elements in a device). The tests are conducted in an air stream and the GPACM configurations are challenged with test gases under steady-state conditions. Since elevated gas challenge concentrations (relative to general ventilation applications) are used, test data should be used to compare GPACM within the same configuration and not for the purpose of predicting performance in a real situation. It is also not implied that different GPACM configurations can be directly compared. The primary intention is to be able to compare like GPACM configurations to like, not between GPACM configurations. Testing of complete devices is described in ISO/FDIS 10121-2.

To ensure objectivity for test equipment suppliers no specific design of the test apparatus will be normative. Instead normative demands for media sample holder design, apparatus properties and validation tests will be specified.

2 Normative references

This Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

ISO 29464	Air filters for general air cleaning — Terminology
ISO 10121-2	Test methods for assessing the performance of gas-phase air cleaning media and devices for general ventilation- Gas Phase Air Cleaning Devices (GPACD)
ASTM D2854	Standard Test Method for Apparent Density of Activated Carbon

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 29464 and the followings apply:

3.1
absorption:
transport and dissolution of a sorbate into an absorbent.

3.2
adsorbate:
any molecular compound in gaseous or vapour phase that will be retained by the adsorbent material of the media.

3.3
adsorbent:
material that collects adsorbates on its surface through physical or chemical processes.

3.4
adsorption:
process in which the molecules of a gas 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.

3.5
breakthrough*:*
point when the effluent contaminant concentration becomes measurable when GPAC Media or Device is in the process of removing gaseous contaminants from an air stream; alternatively, the amount of gaseous contaminant in the effluent of a GPAC Media or Device (see penetration)

3.6
breakthrough vs time curve:
plot of contaminant penetration versus time for a particular challenge concentration and airflow.

3.7
bypass:
proportion of the challenge air stream that passes around the GPAC Media or Device without contacting the media.

3.8
capacity (m_s):
amount (mass or moles) of a selected sorbate that can be contained in the GPAC Media or Device at given test conditions, and a specific end point. Capacity can also be negative during desorption.

3.9
challenge concentration:
concentration of the test contaminant(s) of interest in the air stream prior to filtration (challenge air stream).

3.10
challenge compound:
chemical compound that is being used as the contaminant of interest for any given test.

3.11
challenge air stream:
test contaminant(s) of interest diluted to the specified concentration(s) of the test prior to filtration.

3.12
channeling:
disproportionate or uneven flow of gas through passages of lower resistance due to inconsistencies in the design or production of a GPACM sample holder or a GPACD, particularly in packed granular beds

3.13
chemisorption (chemical adsorption):
trapping of gaseous or vapour contaminants on an adsorbent involving chemical reaction on the adsorbent surface.

3.14
concentration (C_n):
quantity of one substance dispersed in a defined amount of another. Indices *n* denote location.

3.15
contaminant:
substance (solid, liquid, or gas) that negatively affects the intended use of a fluid

3.16
decay time (t_{Dn}):
time required for the gas contaminant monitoring instrument to record a reduction from greater than 95% of the challenge concentration to less than 5% of the challenge concentration (t_{END} - t_{VC}) at the downstream sampling point for a specific test (n), challenge gas and gas flow after stopping the injection of the contaminant with no GPAC Media or Device present.

3.17
desorption:
opposite of adsorption, in which adsorbate molecules leave the surface of the adsorbent and re-enter the air stream.

3.18
downstream:
area following the filter in the direction of fluid flow.

3.19
efficiency vs time curve:
plot of the GPAC Media or Device removal efficiency against time over the duration of a challenge test for a particular challenge concentration and airflow.

3.20
efficiency vs capacity curve:
plot of the GPAC Media or Device removal efficiency against the integrated capacity over the duration of a challenge test for a particular challenge concentration and airflow.

3.21
face velocity
air flow rate divided by the cross sectional area of the GPAC Media or Device.

3.22
gas:
substance whose vapour pressure is greater than the ambient pressure at ambient temperature.

3.23
gas phase air cleaning device (GPACD):
assembly of a fixed size (normally box shaped or fitting into a box of dimensions between 300 x 300 x 300 mm up to ~ 610 x 610 x 610 mm enabling the removal of specific gas- or vapour-phase contaminants.

3.24
GPAC media or device face area:
cross-sectional area of the GPAC Media or Device also including a header frame or other support structures if so equipped when viewed from the direction of air flow using exact dimensions.

3.25
GPACM:
any material used for filtering a gas-phase contaminant - e.g. a porous film or fibrous layer; a granular or pelletized adsorbent (or chemisorbent); a support structure of fabric, foam or monoliths containing adsorbent in the form of small sized particles, granules, spheres or powder; a woven or nonwoven fabric completely made from an adsorbent material.

3.26
GPACM-LF:
adsorbent in the form of particles of different shape and size intended for e.g. loose fill applications

3.27
GPACM-FL:
adsorbent in the form of flat sheet i.e. of flexible, thin, nominally 2-dimensional: such as woven or nonwoven fabrics, wet laid papers, smooth pads, felts etc. normally handled as roll goods

3.28
GPACM-TS:
adsorbent in the form of a three dimensional structure that are many times thicker than flat sheet and e.g. used as finished elements in a device. Examples are flexible open cell structures i.e. of thicker impregnated foam, corrugated pads etc. and air permeable rigid structures i.e. of bonded particles, honeycomb trays, extruded monoliths, etc.

3.29
initial efficiency Ei:
initial efficiency is defined by calculating the intersection of vertical efficiency axis by extrapolation of a linear fit of efficiency vs. time from the values between 2 to 12 minutes of the E vs. time graph generated during test of a GPAC Media or Device

3.30
molecular contamination:
contamination present in gas or vapour phase in an air stream and excluding compounds in particulate (solid) phase regardless of their chemical nature.

3.31
ppb(v):
parts per billion by volume. mm^3/m^3. A concentration measure normally used to record ambient levels of outdoor pollution.

3.32
ppm(v):
parts per million by volume. cm^3/m^3 and ml/m^3. A concentration measure normally used to record pollution levels in e.g. work place safety.

3.33
penetration (P):
ratio of contaminant concentration downstream of the filter to the upstream (challenge) concentration, sometimes expressed as a percentage. Related to efficiency (%) by the expression: Efficiency = (1 - Penetration) x 100%.

3.34
physisorption (physical adsorption)
attraction of an adsorbate to the surface, both outer surface and inner pore surface, of an adsorbent by physical forces (Van der Waals forces)

3.35
pore:
minute passageways through which fluid may pass or that expose to the fluid stream the internal surfaces of an adsorbent media. Three size ranges are defined by The International Union of Pure and Applied Chemistry (IUPAC); macro-pores (> 50 nm), meso-pores (2-50 nm), and micro-pores (< 2 nm).

3.36
pressure drop (Δp):
difference in pressure between two points in an airflow system at specified conditions, especially when measured across a GPAC Media or Device. Also called differential pressure.

3.37
removal efficiency (E):
fraction or percentage of a challenge contaminant that is retained by a GPAC Media or Device at a given time.

3.38
retentivity (m_r):
measure of the ability of an adsorbent or GPAC Media or Device to resist desorption of an adsorbate, computed as the residual capacity (fraction remaining) after purging the adsorbent with clean, conditioned air only, following challenge breakthrough.

3.39
residence time, t_r:
relative time that an increment of fluid (or contaminant) is within the boundaries of the media volume (e.g. a bed of granules or a non woven sheet). In typical use and in this standard this value neglects the fact that the media and possible support structures occupy a significant portion of the volume of the bed [t_R = V (total bed volume) /Q (air flow rate)]

3,40
rise time (t_{Rn}):
time between initial injection of contaminant and reaching 95% of the challenge concentration for an empty duct (t_0 - t_{VO}) measured at the downstream sampling location for a specific test (n), challenge gas and gas flow

3.41
sorbate:
molecular compounds that are retained in the adsorbent of the device. It should be noted that the sorbate will refer to both intended compounds like the selected challenge gas in a test or pollution in real service but also any other compound present in the air stream e.g. gases and vapours.

3.42
sorption:
process in which fluid molecules (gas or liquid) are removed by the GPACM by absorption or adsorption.

3.43
space velocity [sv]:
measure of residence time of the airflow to pass through the adsorbent bed, i.e. sv = volumetric flow rate/total volume of the bed. [sv] = (residence time)$^{-1}$

3.44
vapour:
substance whose vapour pressure is less than the ambient pressure at ambient temperature, but is present in the gas phase through evaporation or sublimation.

4 Symbols and abbreviated terms

Symbol	Explanation
C	concentration
C_U	upstream concentration [ppb, ppm] measured at a position X mm before the media sample or device
C_D	downstream concentration [ppb, ppm] measured at a position Y mm after the media sample or device
d_{pa}	the average particle diameter of a loose fill adsorbent
Δp	pressure drop measured over the tested media sample or device [Pa]
E_C	removal efficiency [%] for the device measured at the challenge concentration selected during the capacity test..
E_{END}	efficiency recorded at stop test time or value agreed between user and supplier [%]

m_r	retentivity; [g],[mol] the amount withheld by the media or device after ventilating with clean air at the same flow selected during the capacity test until C_D reaches a specified value close to zero.
m_{sU}	the integrated amount in moles or gram of challenge compound accumulated during measurement at the upstream position
m_{sD}	the integrated amount in moles or gram of challenge compound accumulated during measurement at the downstream position
m_s	the total integrated amount [g], [mol] of challenge compound accumulated by the GPAC media or device during the whole challenge test
n_p	the number of pores along the (shortest) diameter of a GPACM-TS sample
p_U	upstream pressure [Pa] measured at a position X mm before the media sample or device
p_D	downstream pressure [Pa] measured at a position Y mm after the media sample or device
Q	air flow rate; flow used in test (given by 5.4 or 5.5) [m^3/h] measured at a position Z mm after the media sample or device
Q_A	the average air flow rate calculated from individual measurements evenly distributed over the test period.
RH_U	upstream relative humidity [%] measured at a position X mm before the media sample or device
RH_D	downstream relative humidity [%] measured at a position Y mm after the media sample or device
t	time
t_0	start time. The time when C_U (contamination concentration upstream) equals the selected challenge concentration for an empty sample holder or duct
t_{END}	time when a test is stopped. The time when a desired concentration or other termination criteria have been met in any of the prescribed test procedures (agreed between user and supplier)
t_{DC}	decay time for challenge concentration used in the capacity measurement
t_{RC}	rise time for challenge concentration used in the capacity measurement
t_{VC}	time noted at challenge gas valve closure
t_{VO}	time noted at challenge gas valve opening
T_U	upstream temperature [ºC] measured at a position X mm before the media sample or device
T_D	downstream temperature [ºC] measured at a position Y mm after the media sample or device
v_f	face velocity [m/s] calculated from flow and cross sectional area of media sample or device
x	the minimum recommended distance from the highest part of the sample holder with the same diameter as the upstream side of the sample
X	a position X positioned sufficiently far ahead of the device to allow undisturbed measurements, determined in the validation, annex A. At the position X the concentration of challenge