INTERNATIONAL STANDARD

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Respiratory protective devices — Methods of test and test equipment —

Part 4: Determination of gas filter capacity and migration, desorption and carbon monoxide dynamic testing

Appareils de protection respiratoire — Méthodes d'essai et équipement d'essai —

Partie 4: Détermination de la capacité d'un filtre à gaz et essais de migration, de désorption et dynamique au monoxyde de carbone

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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.

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 16900-4 was prepared by Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 15, *Respiratory protective devices*.

ISO 16900 consists of the following parts, under the general title *Respiratory protective devices — Methods of test and test equipment*:

— *Part 1: Determination of inward leakage*

— *Part 2: Determination of breathing resistance*

— *Part 3: Determination of particle filter penetration*

— *Part 4: Determination of gas filter capacity, migration, desorption and carbon monoxide dynamic testing*

Introduction

This part of ISO 16900 is intended as a supplement to the specific performance standards for respiratory protective devices. Test methods are specified for complete devices or parts of devices. If deviations from the test method given in this International Standard are necessary, these deviations will be specified in the relevant performance standard.

Respiratory protective devices — Methods of test and test equipment —

Part 4: Determination of gas filter capacity and migration, desorption and carbon monoxide dynamic testing

1 Scope

This part of ISO 16900 specifies the test method for determining the gas capacity of separate or integral gas filters and combined filters for respiratory protective devices. It includes the validation test at specified flow rates, a desorption test to access the ability of the filter to retain the adsorbed or absorbed gas, and carbon monoxide dynamic testing.

NOTE These tests are conducted in laboratories using specified test agents under specified conditions and therefore do not indicate the performance of the device in actual use.

2 Normative references

The following referenced documents are indispensable for the application 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 16972, *Respiratory protective devices — Terms, definitions, graphical symbols and units of measurement*

ISO/TS 21748, *Guidance for the use of repeatability, reproducibility and trueness estimates in measurement uncertainty estimation*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 16972 and the following apply.

3.1
sorption
process in which one substance (the filter medium) takes up or holds another (the test gas), either by adsorption or absorption

3.2
desorption
process in which one substance (the filter medium) releases an absorbed or adsorbed substance

3.3
breakthrough time
time taken from the start of the test until the test gas and specified reaction products are detected at the specified breakthrough concentration at the downstream side of the filter under test

3.4
gas filter capacity
mass or volume of a specific test agent that is removed or retained by a gas filter or combined filter under specified conditions of temperature, humidity, challenge test gas concentration and flow rate

NOTE The mass or volume is determined by measuring the breakthrough time at a defined breakthrough concentration. The mathematical equation to calculate the gas capacity is:

$$C = V_{fl} \times c_{gas} \times t_{br} \times 10^{-6}$$

where

C is gas capacity (l);

V_{fl} is volume flow rate (l/min);

c_{gas} is gas concentration (ml/m^3);

t_{br} is breakthrough time (min).

EXAMPLE $V_{fl} = 30$ l/min

$c_{gas} = 1\,000$ ml/m^3

$t_{br} = 30$ min

$C = 30$ l/min $\times$ 1 000 ml/m^3 $\times$ 30 min $\times$ $10^{-6} = 0{,}9$ *l*

3.5
gas filter validation test at specified flow rates
test to evaluate the ability of the filter to achieve a minimum performance level at its work rate classification

3.6
integral dose
volume of the test gas on the effluent side of the filter released during the testing period

NOTE This is calculated as the integral of the instant effluent concentration (function of time) of the test gas during the testing time multiplied by the volume flow rate.

4 Prerequisites

The performance standard shall indicate the conditions of the test. This includes the following:

a) number of specimens;

b) sequence of preconditioning;

c) type of test method (gas capacity test, gas filter validation test at specified flow rates, migration test A or migration test B, desorption test);

d) test parameters for gas capacity test (test gas, concentration, reaction products if applicable, breakthrough concentration, breakthrough time, humidity, temperature, flow mode, flow rate, setting of breathing machine);

e) test parameters for gas filter validation test at specified flow rates (test gas, concentration, reaction products if applicable, breakthrough concentration, breakthrough time, humidity, temperature, flow rate);

f) test parameters for migration and desorption test (test duration, reaction products if applicable, termination, initial exposure prior to desorption).

5 General test requirements

Unless otherwise specified, the values stated in this part of ISO 16900 are expressed as nominal values. Except for temperature limits, values which are not stated as maxima or minima shall be subject to a tolerance of ±5 %. Unless otherwise specified, the ambient temperature for testing shall be between 16 °C and 32 °C and (50 ± 30) % RH. Any temperature limits specified shall be subject to an accuracy of ±1 °C.

6 Principles

6.1 Sorption tests

6.1.1 Gas capacity test

Gas and combined filters are exposed to a defined test gas under given conditions to determine the time when breakthrough of the applied gas occurs at a specified concentration.

6.1.2 Gas filter validation test at specified flow rates

Gas and combined filters are exposed to a defined test gas under enhanced flow rates to evaluate whether breakthrough time exceeds a specified minimum.

6.2 Migration and desorption tests

6.2.1 Migration test A and migration test B

Gas and combined filters are exposed to a defined test gas under given conditions. After exposure, the filter is stored under defined conditions. After storage, clean air (migration test A) or test gas (migration test B) is passed through the filter to determine the ability of the filter to retain the test gas.

6.2.2 Desorption test

Gas and combined filters are exposed to a defined test gas under given conditions. After exposure, clean air is immediately passed through the filter to determine the ability of the filter to retain the test gas.

6.3 Carbon monoxide (CO) dynamic testing of type CO filter

The CO gas filter, or combined filter containing type CO, are exposed to CO under given conditions to determine the effluent CO concentration over time and the integral dose.

7 Apparatus

7.1 Apparatus for constant flow

The test apparatus consists of three modules:

a) challenge gas generator;

b) test chamber;

c) detector.

A schematic drawing of an example for a test apparatus is shown in Figure 1.

7.2 Challenge gas generator

The challenge gas concentration can be generated using several methods. These include:

a) use of a prediluted gas (in air);

b) dilution of a gas by a carrier gas (air);

c) evaporation of a chemical substance into carrier gas (air);

d) *in situ* preparation by a chemical reaction where the product is taken up into carrier gas (air).

It shall be taken into account that the stabilization of the test gas concentration takes some time due to adsorption of test gas at the walls of the gas-generating system and the test chamber.

7.3 Test chamber

The filter test chamber shall be sufficiently large to accommodate the filter system under test and shall allow a homogeneous filter exposure.

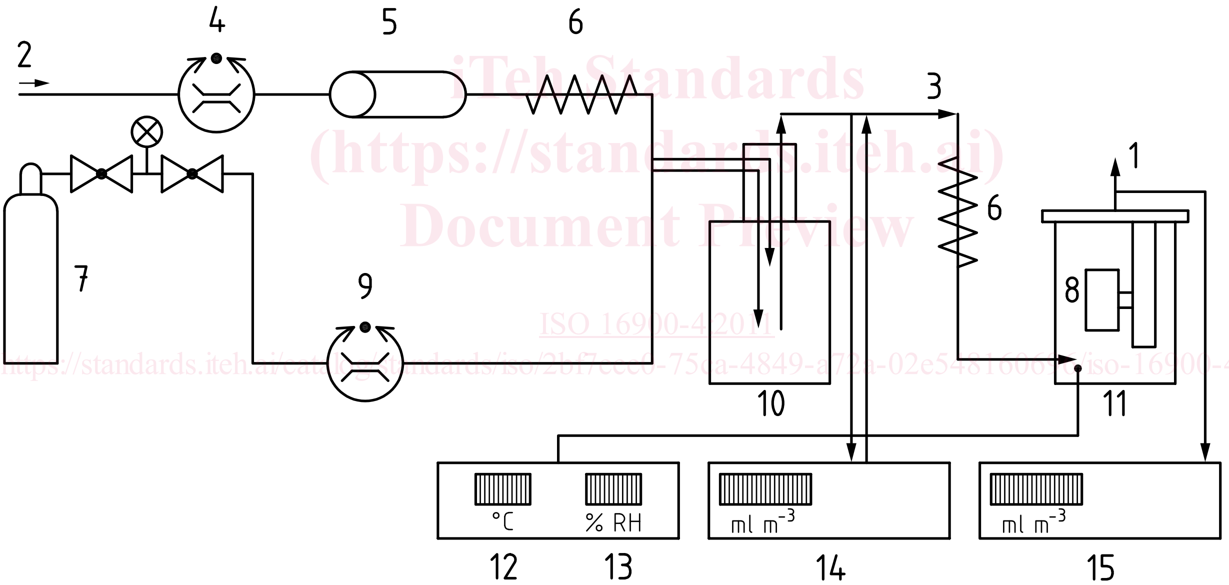
The construction of the chamber shall be resistant to the test gas, shall be leak-tight and shall safely withstand any pressures, either positive or negative, that might be generated.

Specimen orientation shall be such that the gas flows horizontally and in line with the direction of minimum bed depth of the filter. A gas stream shall not directly impact on to the filter face.

7.4 Detector

The response time of the detection system, which includes sampling lines and connections, shall be known and taken into consideration.

The detector shall have sufficient sensitivity and resolution to accurately determine 10 % of the specified breakthrough concentration.



Key

1 exhaust
2 air
3 test gas
4 flow controller
5 humidifier
6 water cooler/thermostat
7 challenge gas
8 test specimen
9 flow controller
10 mixing vessel
11 test chamber
12 detector: temperature
13 detector: relative humidity
14 detector: test gas
15 detector: breakthrough

Figure 1 — Schematic diagram of typical test apparatus for constant flow gas capacity testing

7.5 Apparatus for dynamic flow

Schematic diagrams of test arrangements that have been found suitable are represented by Figure 2. They mainly consist of:

