
**Road vehicles — Air filters for passenger
compartments —**

**Part 2:
Test for gaseous filtration**

*Véhicules routiers — Filtres à air pour l'habitacle —
Partie 2: Essai pour le filtrage des gaz*
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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 3.

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.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

- an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;
- an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed after three years with a view to deciding whether it should be confirmed for a further three years, revised to become an International Standard, or withdrawn. In the case of a confirmed ISO/PAS or ISO/TS, it is reviewed again after six years at which time it has to be either transposed into an International Standard or withdrawn.

Attention is drawn to the possibility that some of the elements of this part of ISO/TS 11155 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TS 11155-2 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 7, *Injection equipment and filters for use on road vehicles*.

ISO/TS 11155 consists of the following parts, under the general title *Road vehicles — Air filters for passenger compartments*:

- *Part 1: Test for particulate filtration*
- *Part 2: Test for gaseous filtration*

Annex A forms a normative part of this part of ISO/TS 11155. Annexes B, C and D are for information only.

Road vehicles — Air filters for passenger compartments —

Part 2: Test for gaseous filtration

1 Scope

This part of ISO/TS 11155 specifies a test comprising several methods for measuring the dynamic gas adsorption of air filters in the passenger compartments of road vehicles. These laboratory test methods are applicable to air filters that improve air quality by reducing concentrations of gaseous, odorous or hazardous components from ambient or recirculated air, or both, in the vehicle cabin. They provide a means of measuring air pressure loss, as well as gas and vapour removal characteristics.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO/TS 11155. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO/TS 11155 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO/TS 11155-1, *Road vehicles — Air filters for passenger compartments — Part 1: Test for particulate filtration*

ISO 11841-1, *Road vehicles and internal combustion engines — Filter vocabulary — Part 1: Definitions of filters and filter components*

ISO 11841-2, *Road vehicles and internal combustion engines — Filter vocabulary — Part 2: Definitions of characteristics of filters and their components*

3 Terms and definitions

For the purposes of this part of ISO/TS 11155, the terms and definitions given in ISO 11841-1 and ISO 11841-2, and the following apply.

3.1

test air flow rate

volume of air passing through the test duct per unit time

NOTE It is expressed in actual cubic metres per hour unit time.

3.2

pressure loss

difference in static pressure measured upstream and downstream of the filter at a specified flow rate

NOTE It is expressed in pascals.

**3.3
contaminant**

unwanted constituent dispersed in air

**3.4
concentration**

mass quantity of one constituent dispersed in another

NOTE It is generally expressed as the mass of contaminant/volume air in milligrams per cubic metre or volume contaminant/volume air in parts per million by volume. See annex D.

**3.5
influent air**

cleaned air used to dilute contaminants and produce the challenge gas

**3.6
challenge gas**

homogeneous mixture of influent air and contaminant used to challenge the filter

**3.7
challenge gas concentration**

ratio of the mass (or volume) of test contaminant per volume of influent air measured under specified conditions

NOTE It is expressed in milligrams per cubic metre or parts per million by volume. See annex D.

**3.8
test gas mass**

total mass of test contaminant (m_T) to which the filter is exposed

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NOTE It is expressed in milligrams.

**3.9
influent concentration**

C_1
homogeneous challenge gas concentration measured before (upstream of) the filter

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NOTE It is expressed in milligrams per cubic metre or parts per million by volume. See annex D.

**3.10
effluent concentration**

C_2
homogeneous challenge gas concentration measured after (downstream of) the filter

NOTE It is expressed in milligrams per cubic metre or parts per million by volume. See annex D.

3.11**efficiency [penetration]**

relative comparison of the amount of contaminant removed or reduced by the filter compared to the amount exposed to it, calculated as a percentage by

$$E = \frac{100(C_1 - C_2)}{C_1} \quad (1)$$

where

E is efficiency

C_1 is the influent concentration

C_2 is the effluent concentration

NOTE 1 Percentage penetration = 100 % – percentage efficiency.

NOTE 2 Percentage breakthrough = 100 % – percentage efficiency.

3.11.1**1 min efficiency**

efficiency measurement 1 min after time zero (t_0)

3.11.2**2 min efficiency**

efficiency measurement 2 min after t_0

3.11.3**5 min efficiency**

efficiency measurement 5 min after t_0

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3.12**time zero**

t_0

calculated zero point based on the shape of the ramp-up curve of gas challenge breakthrough versus time

See clause 7 and annex B.

NOTE 1 Once this curve is obtained, the t_0 point can be found by calculation. All efficiency or penetration data is calculated from the designated t_0 .

3.13**start of test time**

t_{start}

time at which the challenge gas is introduced into the test system

3.14**lag time**

t_{lag}

time difference between t_{start} and t_0

See annex B.

3.15**end of test time**

t_f

time at which a user-specified efficiency (typically 5 %) or user-specified time is reached

3.16
total test time

duration of exposure of the filter to the challenge gas, beginning at t_0

3.17
capacity

m_c
mass of contaminant removed from the challenge gas stream by the filter during the total test time

NOTE It is normally expressed in milligrams.

3.18
desorption

release of previously trapped contaminants from a test filter

4 Measurement accuracy

4.1 Flow rate monitors

The measurement devices are to be calibrated relative to the respective challenge or contaminant gases. Their accuracy shall be within $\pm 3\%$ of the specified value.

4.2 Pressure monitors

The differential pressure shall be within $\pm 2\%$ of the measured value.

4.3 Temperature

Temperature shall be monitored to within $\pm 0,5\text{ }^\circ\text{C}$ accuracy.

4.4 Relative humidity

Relative humidity shall be monitored to within $\pm 2\%$.

4.5 Challenge gas measurement accuracy

Challenge gas measurement accuracy for *n*-butane, toluene and SO₂ shall be $\pm 3\%$.

5 General conditions

5.1 Conditioning of air

The temperature of the challenge gas mixture shall be $23\text{ }^\circ\text{C} \pm 3\text{ }^\circ\text{C}$ and the relative humidity $50\% \pm 2\%$.

5.2 Cleanliness of influent air

The content of organic contaminants in the influent air must not exceed the equivalent of a volume fraction of 2×10^{-6} (parts per million by volume¹⁾) of total hydrocarbon. HEPA filtration is recommended for the removal of particulate contaminants.

1) The unit "ppm", or a unit derived from it, is a deprecated unit, i.e. not accepted by the International System of Units, SI.

5.3 Challenge gas concentration stability

Inlet challenge gas concentration shall be maintained to within $\pm 3\%$ of set concentration for the duration of the test.

6 Test contaminants

6.1 Mandatory contaminants

Mandatory test contaminants are chosen either because their presence at high levels signifies deterioration in air quality or because they provide useful indications of performance for certain types of purification systems. Mandatory contaminants, purities and concentrations are specified in Table 1.

Table 1 — Test contaminants

Test contaminant	Minimum purity %	Concentration	
		Set point parts per million by volume ^b	Conversion Factor ^c ×
<i>n</i> -butane ^a	99,5	80 ± 8	2,39
Toluene	99,5	80 ± 8	3,79

^a Included because it provides a useful and facile test for activated carbon-based adsorption systems. Butane could be of limited value for systems that do not rely on activated carbon adsorption. In these cases, another test contaminant may be substituted.

^b See annex D for conversion to SI units.

^c Allows conversion to milligrams per cubic metre at 23 °C and a barometric pressure of 101 kPa (1,0 atm).

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6.2 Optional contaminants

Tests using the optional contaminant are subject to agreement between customer and manufacturer. Recommended contaminants, purities and concentrations are given in Table 2.

Table 2 — Optional test contaminant

Test contaminant	Minimum purity %	Concentration	
		Set point parts per million by volume ^b	Conversion Factor ^c ×
SO ₂ ^a	99,5	30 ± 3	2,64

^a Included because it can be used to represent the family of acid gases in determining the performance of carbon-based adsorption systems.

^b See annex D for conversion to SI units.

^c Allows conversion to milligrams per cubic metre at 23 °C and barometric pressure of 101 kPa (1,0 atm). (The unit for standard atmosphere, "atm", is a deprecated unit, i.e. not accepted by the International System of Units, SI.)

6.3 Other contaminants

See annex C for other contaminants. The use of other gases could be of interest for dedicated applications. Gases of interest shall be agreed between customer and manufacturer.

7 Test equipment

7.1 General layout

The test stand shall meet the performance requirements given in 7.2 to 7.7. An example of a test stand configuration is given in annex A (see Figure A.1). All parts of the system which come into contact with the challenge gas shall be chosen and designed such that they are chemically resistant and errors due to adsorptive effects on part surfaces are minimized. The test stand shall include equipment or apparatus for conditioning the air supply, flow measurement, pressure drop measurement, contaminant injection, sampling and sample analysis.

The test stand/equipment should preferably be operated in a sub-barometric pressure mode, i.e. with the fan/blower placed downstream of the sample. This configuration prevents penetration of challenge gas into the ambient atmosphere in case of equipment leaks. Furthermore, systematic errors due to the challenge gas contacting the fan unit are excluded. Although operation in a sub-barometric pressure mode is preferred for these reasons, a system operating in a positive pressure mode that meets the requirements of 7.2 to 7.7 is acceptable.

7.2 Test stand performance

The test stand shall be validated as part of the overall test system (stand and associated equipment) as given in clause 11. Validation shall be performed whenever test conditions (e.g. flow rate) or test stand configuration (e.g. mixing or fixture) are altered significantly. Test instruments shall be calibrated in accordance with the manufacturer's recommended practice and frequency.

7.3 Air supply

The influent air shall be conditioned and cleaned in accordance with 5.1 and 5.2. The system shall demonstrate the ability to maintain these conditions over the period of time required to complete a filter evaluation. The system shall be capable of delivering and maintaining a user-specified flow.

7.4 Test duct

In general, the test duct shall be designed so that adsorption of test contaminants on test stand surfaces is minimized. The test duct is to be designed so that the challenge gas is fed evenly to the complete filter surface. Punched sheets, static mixers or deflectors can be useful for this purpose. Mixing of the injected test contaminant with the test duct's air will require rigorous attention and validation. In general, a duct similar to that described in ISO/TS 11155-1 (particulate) may be used to meet these specifications. However, those design details of the ISO/TS 11155-1 layout that are specific to particle handling and measurement, and which do not influence the handling and measurement of gases, are not obligatory for the test equipment.

7.5 Contaminant generation and supply

Test contaminants that are already gaseous under test conditions may be supplied to the duct directly.

Test contaminants that are liquid under test conditions (e.g. toluene) shall be volatilized prior to injection into the duct. This can be accomplished by heating or providing energy by ultrasonic or other means. The temperature requirements given in 5.1 also apply in this particular case. Furthermore, condensation of test contaminants shall be avoided by appropriate means (e.g. heating, duct design), especially in the vicinity of the contaminant injection area.

Test contaminants generated via chemical reaction, for example, NO₂, shall be generated in a separate chamber and subsequently injected into the duct in order to ensure the required contaminant chemical purity.

7.6 Sampling and analysis of challenge gas

The challenge gas is sampled upstream and downstream of the test filter. Placement of the sampling ports shall give representative samples. This shall be validated in accordance with clause 11. A defined partial flow shall be extracted from the test duct, preferably by means of an independently controlled flow to the gas analyser.

Sampling frequency should be frequent enough so that a meaningful efficiency curve can be created. A suggested initial guideline is once every 10 s, or as frequently as possible for the analyser used. For long tests, a lesser sampling frequency is acceptable, provided the efficiency curve is sufficiently well defined.

7.7 Test equipment constituents

7.7.1 Flow rate monitors

The measurement devices shall be calibrated relative to the respective test gases and to the accuracy specified in 4.1.

7.7.2 Pressure monitors

The differential pressure shall be measured by means of a high-precision pressure sensor or gauged electronic pressure sensor to the accuracy specified in 4.2.

7.7.3 Temperature

Temperature shall be monitored to the accuracy specified in 4.3.

7.7.4 Relative humidity

Relative humidity shall be monitored to the accuracy specified in 4.4.

7.7.5 Data recording

Data relative to temperature, barometric and differential pressure and relative humidity shall be recorded periodically.

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7.7.6 Gas analysers

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Gas analysers shall completely cover the range of concentration values specific to the respective challenge gas. A detection limit of 5 % of the upstream concentration shall be assured. A calibration function shall be determined over the complete range of concentration values for each contaminant gas. The concentration shall be measured to the accuracy specified in 4.5. The analyser's signal-to-noise ratio (S/N) shall exceed 3.

A gas analyser sampling frequency of 10 s, or often enough to produce a meaningful curve, is recommended. The concentration of the challenge gas downstream of the filter, C_2 , is to be sampled at this frequency. For configurations that show low change in downstream concentration, the sampling frequency may be reduced to 1 min, provided that the change in downstream concentration meets the required accuracy during the respective period. This applies especially to the period when the downstream concentration is below the analysers' detection limit. The sampling frequency shall be increased early enough to a value of 10 s, or more often, such that the increase in downstream concentration at this higher sampling frequency is completely recorded. The period with reduced sampling frequency shall be determined in a preceding, separate, test run.

8 Experimental determination of t_0 , using t_{lag}

This shall be carried out using the following procedure.

- a) Stabilize the challenge gas feed concentration and air flow.
- b) Send the gas to the exhaust.
- c) Insert the sample holder without filter into the test duct.
- d) Allow the instrument to return to a zero concentration reading.