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Road vehicles — Detection of exhaust system leaks — Helium test method and detection device specification

Véhicules routiers — Détection des fuites du dispositif d'échappement — Méthode d'essai à l'hélium et spécification du dispositif de détection

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

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ISO 16247 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 5, *Engine tests*.

Road vehicles — Detection of exhaust system leaks — Helium test method and detection device specification

1 Scope

This International Standard specifies a helium test method for detecting and localizing gas leaks in the exhaust systems of road vehicles equipped with an internal combustion engine, in order to improve the quality of exhaust gas measurements. In doing so, it completes the requirements of ISO 3929, applicable regulations and, depending on the leak rate to be detected, ISO 13556. The method is particularly applicable for use in automotive workshops, by end-of-line of automotive and exhaust parts manufacturers, in laboratories prior to exhaust emission tests, and in testing and diagnosis stations.

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 3929, *Road vehicles — Measurement methods for exhaust gas emissions during inspection or maintenance*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
exhaust system
all parts between the joint face of the cylinder head(s) and the outlet pipe(s)

3.2
leak
outward exhaust gas flow or inward air flow which can affect the exhaust emissions measurement result

3.3
tracer gas
gas used for detecting leaks

NOTE The method specified by this International Standard uses helium as the tracer gas.

3.4
detection device
device designed to detect low concentrations of specified tracer gas and so facilitate the location of leaks

3.5
pressurisation device
device used to keep the exhaust system at the pre-determined pressure

3.6
restriction and calibration device
device designed to increase the pressure in the exhaust line, in order to facilitate the detection and localization of leaks, and to gauge the exhaust line involving tracer gas introduced by a plugged outlet

3.7

detection time

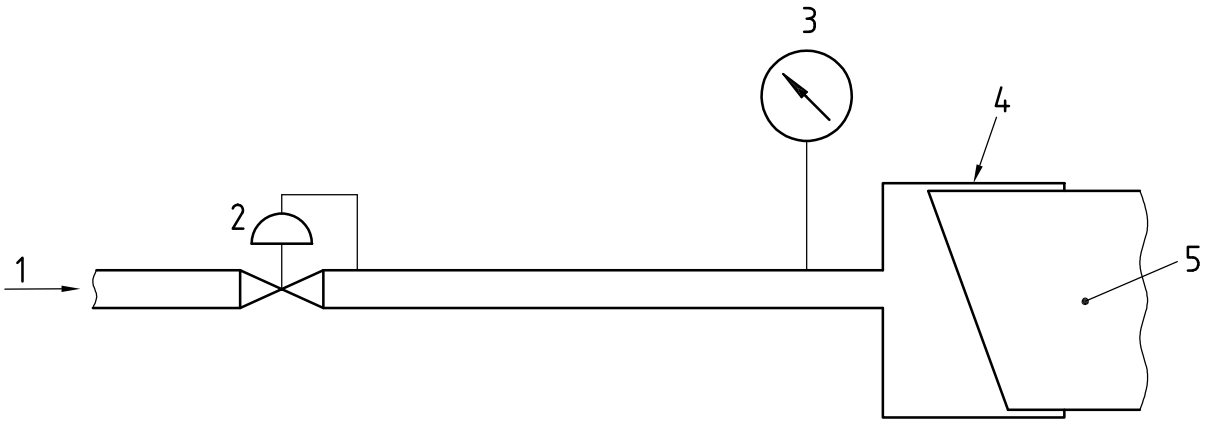
time needed to obtain a signal useful for the operator which indicates a leak equivalent to a 0,1 mm diameter hole with the engine running at idle speed and 2 % helium (He) in the exhaust gas flow

4 Apparatus

4.1 Equipment for auditive detection

This shall consist of the following.

4.1.1 Pressurization device, comprising the following (see Figure 1).



Key

1 air
2 pressure regulator
3 manometer
4 flexible connecting device
5 exhaust outlet

Figure 1 — Pressurization device

4.1.1.1 Supply of clean, dry, oil-free and compressed air, capable of maintaining the pressure given in 5.2 b).

4.1.1.2 Adjustable pressure regulator, with a limit of 40 kPa$(= 0{,}4$ bar)[1)].

4.1.1.3 Manometer, suitable and having an accuracy of $\pm$ 2 %.

4.1.1.4 Flexible, leak-proof connecting device, used to connect the pressurization device to the exhaust outlet, and adaptable to external or internal exhaust outlet tubing.

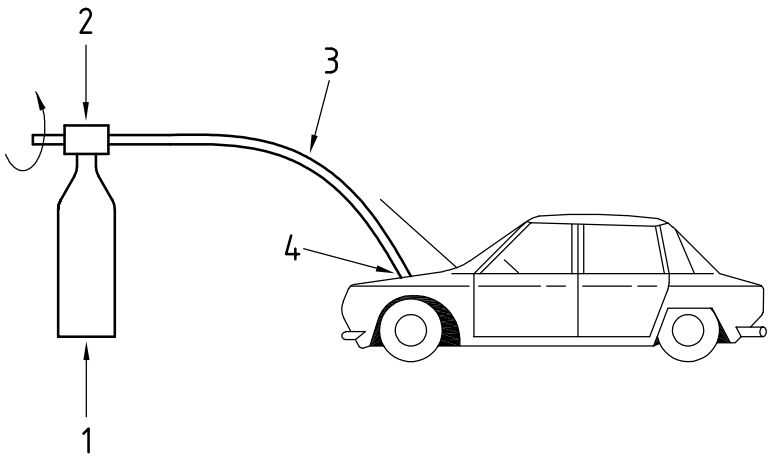
For exhaust systems with multiple outlets, each outlet shall be pressurized and tested separately. Outlets not pressurized shall be plugged.

1) 1 bar $= 0{,}1$ MPa $= 10^5$ Pa; 1 MPa $= 1$ N/mm^2

4.2 Equipment for helium detection

This shall consist of the following.

4.2.1 Tracer gas injection device, comprising the following (see Figure 2).



Key

1 gas bottle
2 flow-rate adjusting device
3 gas injection pipe
4 engine air intake

Figure 2 — Helium injection device

4.2.1.1 Industrial helium gas bottle, with gas flow-rate adjusting device.

4.2.1.2 Gas injection pipe, to be connected to the engine air intake.

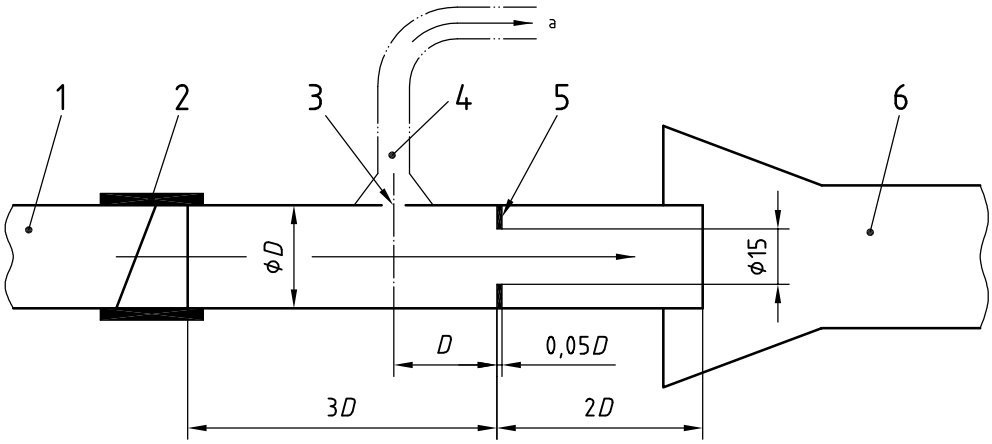
4.2.2 Connecting device for connecting the restriction and calibration device (4.2.3), adaptable to external or internal exhaust outlet tubing, and sufficiently flexible and leak-proof.

4.2.3 Restriction and calibration device, its restriction part being used to add 3 kPa (= 0,03 bar) pressure in the exhaust line, in order to make all leaks from the exhaust line positive compared to the initial state and render the detection more convenient, and its calibration part constituted by a 1 mm diameter calibrated hole for adjusting the helium concentration needed during the leak check.

NOTE Generally, in order to obtain a pressure increase of 3 kPa (= 0,03 bar), it is sufficient to reduce the exhaust outlet section to 15 mm with a section reducer.

See Figure 3.

Dimensions in millimetres



Key

1 exhaust outlet
2 flexible connecting device
3 1 mm diameter calibrated hole
4 sampling line
5 restriction device
6 gas outlet

[a] To the helium detector.

Figure 3 — Restriction and calibration device

4.2.4 Detection device, having the following characteristics and requirements.

— All components of its gas handling system shall be made of corrosion-resistant material, the material employed for the line shall not retain helium, and the material of the sampling probe shall withstand the exhaust gas temperature (200 °C) and shall be rigid.

— It shall have both a handheld display and an audio leak indicator.

— The sampling line tube length shall be at least 6 m.

— The sampling probe (see Figure 4) shall guarantee the accessibility to any area around the exhaust system.

— The sampled gas flow shall be filtered to remove any water and dust.

— The equipment shall provide a warning message to the operator when the sampled flow is insufficient.

— There shall be a 20 000 µl/l (= 20 000 ppm by volume)[2)] helium (He) mark on the display (see Figure 5).

— The detection device shall have

1) a detection time $\leqslant$ 5 s,

2) sensitivity only to helium,

3) a capacity to detect a calibrated leak of 1 mm diameter under optimal detection conditions, with the engine running at the idle speed and 20 000 µl/l (= 20 000 ppm by volume) helium in the exhaust gas flow,

2) "Parts per million (ppm)" is a deprecated unit, i.e. not accepted by the International System of Units, SI. It is used exceptionally in this International Standard, in parentheses, immediately following the SI unit of equivalent value in order to correspond to other, closely related and already published, standards. The accepted SI form for the expression of a volume fraction is in units of microlitres per litre (µl/l), or, alternatively, as 10^{-6} or as a percentage volume fraction (% volume fraction). See ISO 31-0:1992, 2.3.3, and ISO 31-8:1992.

4) a constant flow chosen to obtain the maximum reading sensitivity, and

5) when using a car running at idle speed or an equivalent gas generator, under optimal measurement conditions, the conventional calibration curve given in Figure 6, using a pipe with calibrated leaks of 0,1 mm, 0,2 mm, 0,5 mm, 0,8 mm and 1 mm.

— The detection device shall operate under the following conditions:

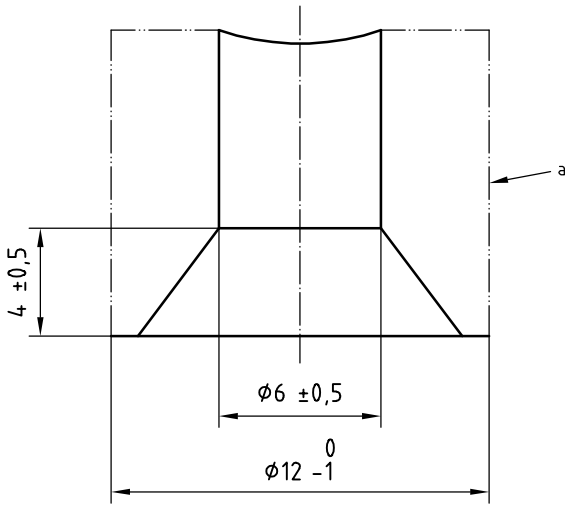
1) power supply appropriated to local standards and the user's needs;

2) ambient temperature of 5 °C to 40 °C;

3) relative ambient humidity of 90 % max;

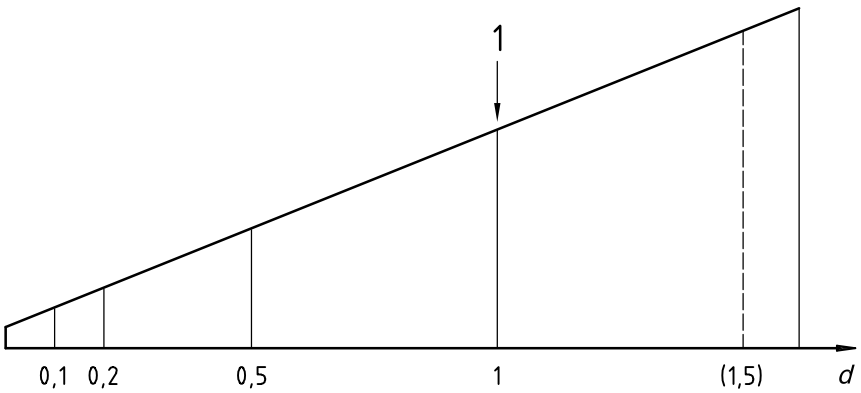
4) ambient pressure of 860 hPa to 1 060 hPa.

Dimensions in millimetres



[a] Dimensions and external shapes are free choice.

Figure 4 — Sampling probe

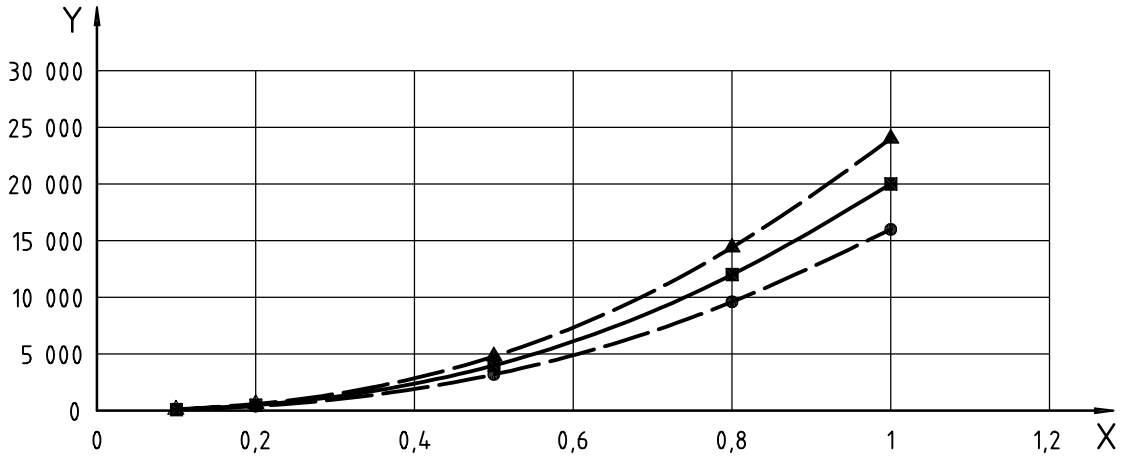


Key

d leak diameter, in mm

1 20 000 µl/l (= 20 000 ppm) mark

Figure 5 — Display scheme



X hole diameter, mm

Y helium µl/l (ppm)

Figure 6 — Apparatus calibration data

5 Test method

5.1 General

The search for leaks is made in two main steps.

— Step 1: engine stopped — auditive detection — exhaust line pressurized.

— Step 2: engine running at idling speed — hot exhaust system — detection using helium tracer gas.

5.2 Procedure — Step 1

The aim of this procedure is to detect major exhaust system leaks, corresponding to holes 1,5 mm to 2 mm diameter and greater, in preparation for Step 2. It may be performed with the exhaust system hot, or cold and pressurized.

a) Install the pressurization device at the exhaust outlet as shown in Figure 1.

b) Pressurize the exhaust system to 0,4 kPa $\pm$ 0,05 kPa ($=$ 0,4 bar $\pm$ 0,05 bar).

c) Detect and localize the leak; listen for the whistling which proves the presence of leak. The operator may be aided by the feeling of the air jet on his hand.

d) Repair the leak on the defective part(s) according to the vehicle manufacturer's instructions.

e) After repair, check again that there are no audible leaks.

f) Remove the pressurization device.

g) Before proceeding to Step 2, warm up the vehicle in accordance with either the manufacturer's instructions or ISO 3929.

5.3 Procedure — Step 2

The aim of this procedure is to detect exhaust systems leaks corresponding to up to a 0,1 mm diameter hole, using helium tracer gas.

a) Install the equipment in accordance with Figure 7.

b) Check that the detection device is prepared for detecting leaks following the manufacturer's instructions.

c) Install the restriction and calibration device in accordance with Figure 3 at the exhaust line outlet, with the sampling probe over the 1 mm diameter hole.

d) Install the helium tracer gas injector device at the engine air inlet in accordance with Figure 2.

e) Slowly adjust the helium while the engine is running at idling speed, so that the display device is aligned at the 20 000 µl/l (= 20 000 ppm by volume) He indicator mark (see Figure 5). Do not make any further adjustment.

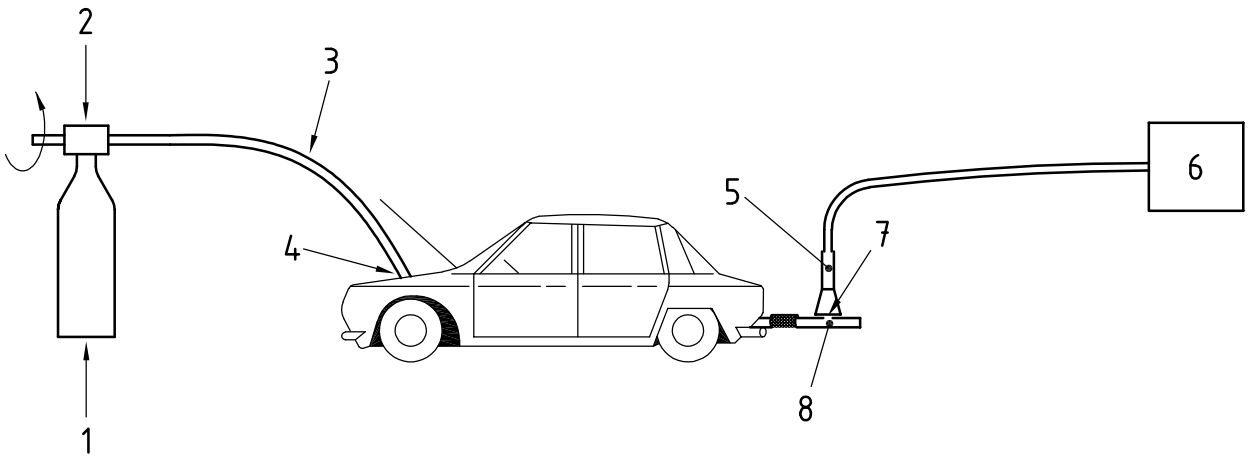
f) Remove the sampling probe from the 1 mm diameter hole. Plug the hole after removing the probe.

g) Scan the whole exhaust line with the sampling probe. The audio signal indicates a leak (the gap between the sampling probe and the walls of the exhaust lines should be no greater than 2 cm).

h) Look for the maximum signal in order to localize the position of the first leak. Mark this leak. Continue to scan the whole exhaust system and do the same in order to localize other potential leaks.

i) Turn off the supply of helium at the bottle and stop the engine.

j) After repairing all the identified leaks, repeat e) to i) until no further leaks are detected.



Key

1 gas bottle
2 flow-rate adjusting device
3 gas injection pipe
4 engine air intake
5 detection device
6 helium detector
7 0,1 mm diameter calibrated hole
8 pressurization device

Figure 7 — Test set-up — Step 2

Bibliography

[1] ISO 13556, *Road vehicles — Localization of exhaust system leaks and equipment specifications*

[2] ISO 31-0:1992, *Quantities and units — Part 0: General principles*

[3] ISO 31-8:1992, *Quantities and units — Part 8: Physical chemistry and molecular physics*

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