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Interior air of road vehicles —

Part 1: Whole vehicle test chamber — Specification and method for the determination of volatile organic compounds in cabin interiors

Air intérieur des véhicules routiers —

Partie 1: Enceinte d'essai pour un véhicule complet — Spécification et méthode de détermination des composés organiques volatils dans les habitacles d'automobiles

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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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 146, *Air quality*, Subcommittee SC 6, *Indoor air*.

This second edition cancels and replaces the first edition (ISO 12219-1:2012), which has been technically revised.

The main changes compared to the previous edition are as follows:

— Adaption of temperatures, number of samples to be taken and the pre-conditioning and measuring times to be consistent with the UN mutual resolution concerning the common definitions of vehicle categories, masses and dimensions.

A list of all parts in the ISO 12219 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

Volatile organic compounds (VOCs) are widely used in industry and can be emitted by many everyday products and materials. They have attracted attention in recent years because of their impact on indoor air quality. After homes and workplaces, people spend a lot of time in their vehicles. It is important to determine the material emissions of interior parts and to reduce them to an acceptable level, if required. Therefore, it is necessary to obtain comprehensive and reliable information about the types of organic compounds in the interior air of vehicles and also their concentrations.

This document outlines a method of measuring the types and levels of VOCs in vehicle cabin air under controlled conditions. It describes requirements for a whole vehicle test chamber and a test protocol. Measurements are carried out according to ISO 16000-6 (VOCs) and ISO 16000-3 (carbonyl compounds).

There are several national test methods available for measuring in-vehicle air quality, e.g. References [2] [4]. However, this document requires a fixed heating radiation system whereas the methods of References [2][3] define a fixed temperature programme.

Before setting a fixed radiation density for heating the test vehicle, several validation measurements were performed (Reference [1]).

ISO 16000-3, ISO 16000-5,[6] ISO 16000-6, ISO 16000-9,[7] ISO 16000-10,[8] ISO 16000-11,[9] ISO 16000-24,[10] ISO 16000-25,[11] as well as ISO 16017-1 and ISO 16017-2[12] also focus on volatile organic compound (VOC) measurements.

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Interior air of road vehicles —

Part 1:
Whole vehicle test chamber — Specification and method for the determination of volatile organic compounds in cabin interiors

1 Scope

This document specifies the whole vehicle test chamber, the vapour sampling assembly and the operating conditions for the determination of volatile organic compounds (VOCs), and carbonyl compounds in vehicle cabin air. There are three measurements performed: one (for VOCs and carbonyl compounds) during the simulation of ambient conditions (ambient mode) at standard conditions of 23 °C - 25 °C with no air exchange; a second only for the measurement of formaldehyde at elevated temperatures (parking mode); and a third for VOCs and carbonyl compounds simulating driving after the vehicle has been parked in the sun starting at elevated temperatures (driving mode). For the simulation of the mean sun irradiation, a fixed irradiation in the whole vehicle test chamber is employed.

The VOC method is valid for measurement of non-polar and slightly polar VOCs in a concentration range of sub-micrograms per cubic metre up to several milligrams per cubic metre. Using the principles specified in this method, some semi-volatile organic compounds (SVOC) can also be analysed. Compatible compounds are those which can be trapped and released from the Tenax TA®[1)] sorbent tubes described in ISO 16000-6, which includes VOCs ranging in volatility from *n*-C_6 to *n*-C_{16}.

The sampling and analysis procedure for formaldehyde and other carbonyl compounds is performed by collecting air on to cartridges coated with 2,4-dinitrophenylhydrazine (DNPH) and subsequent analysis by high performance liquid chromatography (HPLC) with detection by ultraviolet absorption. Formaldehyde and other carbonyl compounds can be determined in the approximate concentration range 1 $\mu g/m^3$ to 1 mg/m^3.

The method is valid for passenger cars, as defined in ECE-TRANS-WP.29/1045.

This document gives guidelines for:

a) transport and storage of the test vehicles until the start of the test;

b) conditioning for the surroundings of the test vehicle and the test vehicle itself as well as the whole vehicle test chamber;

c) conditioning of the test vehicle prior to measurements;

d) simulation of ambient air conditions (ambient mode);

e) formaldehyde sampling at elevated temperatures (parking mode);

f) simulation of driving after the test vehicle has been parked in the sun (driving mode).

1) Tenax TA® is the trade name of a product supplied by Buchem. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

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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 9060, *Solar energy — Specification and classification of instruments for measuring hemispherical solar and direct solar radiation*

ISO 16000-3, *Indoor air — Part 3: Determination of formaldehyde and other carbonyl compounds in indoor air and test chamber air — Active sampling method*

ECE-TRANS-WP.29/1045, *Special resolution No 1, Concerning the common definitions of vehicle categories, masses and dimensions (S.R. 1)*

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
background concentration
substance concentrations in the whole vehicle test chamber when the test vehicle is inside

3.2
test vehicle
new *category 1-1 vehicle* (3.12), not older than 28 d ± 5 d after the *production date* (3.13) to be tested.

Note 1 to entry: Excludes busses used for public transport and trucks only used for the transport of goods

3.3
total volatile organic compounds
TVOCs
sum of volatile organic compounds sampled on Tenax TA®[1)] and eluting between and including *n*-hexane and *n*-hexadecane, detected with a flame ionization detector ($TVOC_{FID}$) or mass spectrometric detector ($TVOC_{MS}$) and quantified converting the total area of the chromatogram in that analytical window to toluene equivalents

3.4
carbonyl compound
compound containing the functional group -C(=) determined according to specified procedure

Note 1 to entry: For the purposes of this document. The procedure is that specified in ISO 16000-3.

3.5
ambient mode
mode in which sampling of substances in the interior air of a test vehicle under standardized ambient temperature conditions is performed, defined by 23 °C - 25 °C, as close as possible to 25 °C

3.6
parking mode
mode in which sampling of substances in the interior air of a test vehicle under elevated temperatures resulting from defined external heat radiation is performed

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3.7
driving mode
mode in which sampling of substances in the interior air of a test vehicle, under standardized conditions starting at elevated temperatures and with the engine on using air conditioning

Note 1 to entry: Driving is simulated with an idle test procedure of a vehicle driven after being parked in the sun

3.8
breathing zone
semi-sphere area with 50 cm radius in front of the drivers face

3.9
sampling train
apparatus to collect the air sample inside the test vehicle cabin from the breathing zone and to collect the air sample from in the whole vehicle test chamber, trapping the test substances in sorbent tubes under standardized conditions

3.10
volatile organic compound (VOC)
volatile organic compound, ranging in volatility from *n*-C_6 to *n*-C_{16}

EXAMPLE Benzene, toluene, xylene, ethylbenzene and styrene.

3.11
production date
date a new vehicle leaves the production line

3.12
category 1 vehicle
power-driven vehicle with four or more wheels designed and constructed primarily for the carriage of (a) person(s)

3.13
category 1-1 vehicle
category 1 vehicle (3.12) comprising not more than eight seating positions in addition to the driver's seating position

Note 1 to entry: A category 1-1 vehicle cannot have standing passengers.

4 Apparatus and materials

4.1 General

The whole vehicle test chamber is big enough to house the test vehicle completely. An air-conditioning system is installed to allow standardized air conditions for a temperature of 23 °C - 25 °C and for a humidity of 50 % RH ± 10 % RH. A solar radiator system is installed to heat the test vehicle cabin with a fixed irradiation. The resulting temperature inside the cabin depends on the insulation and the window glass material (the minimum requirements are specified in 6.1) (see also Figure 1).

4.2 Heating radiator

Infrared radiator, halogen radiator or other radiators (simulating sunlight) (wavelengths < 300 nm shall be filtered out). The heating radiators used shall be powered to create a radiation density at the reference measurement point in the middle of the roof surface of the test vehicle of 350 W/m^2 to 450 W/m^2 (400 W/m^2 ± 50 W/m^2).

The heating area shall cover at least the area of the test vehicle cabin and an additional 0,5 m more to each side of the lower part of the glazing (footprint) (see Figure 1). Position the heating radiators on the roof with a shining angle of 90° to the heating area. There shall be no heating radiators shining from the

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