INTERNATIONAL STANDARD

ISO 16000-2

First edition
2004-07-01

Indoor air —

Part 2: Sampling strategy for formaldehyde

Air intérieur —

Partie 2: Stratégie d'échantillonnage du formaldéhyde

Reference number
ISO 16000-2:2004(E)

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Published in Switzerland

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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 16000-2 was prepared by Technical Committee ISO/TC 146, *Air quality*, Subcommittee SC 6, *Indoor air*.

ISO 16000 consists of the following parts, under the general title *Indoor air*:

— *Part 1: General aspects of sampling strategy*

— *Part 2: Sampling strategy for formaldehyde*

— *Part 3: Determination of formaldehyde and other carbonyl compounds — Active sampling method*

— *Part 4: Determination of formaldehyde — Diffusive sampling method*

— *Part 6: Determination of volatile organic compounds in indoor and test chamber air by active sampling on Tenax TA sorbent, thermal desorption and gas chromatography using MS/FID*

The following parts of ISO 16000 are under preparation:

— *Part 5: Sampling strategy for volatile organic compounds (VOCs)*

— *Part 7: Sampling strategy for determination of airborne asbestos fibre concentrations*

— *Part 8: Ventilation rate measurement*

— *Part 9: Determination of the emission of volatile organic compounds — Emission test chamber method*

— *Part 10: Determination of the emission of volatile organic compounds — Emission test cell method*

— *Part 11: Determination of the emission of volatile organic compounds — Sampling, storage of samples and preparation of test specimens*

Introduction

This part of ISO 16000 describes basic aspects to be considered when working out a sampling strategy for the analysis of formaldehyde in indoor air.

NOTE The term “formaldehyde” is used in this International Standard instead of the term “methanal”, as specified by IUPAC regulations.

It is intended to be a link between Part 1 of ISO 16000, which describes a measurement strategy, and Parts 3 and 4 of ISO 16000, which describe the analytical procedures dealing with active or diffusive sampling of formaldehyde respectively. This part of ISO 16000 presupposes knowledge of Part 1 of ISO 16000.

The sampling strategy procedure is based on VDI 4300, Part 3[1].

VOC measurements in different fields of air pollution are described in ISO 16017, *Indoor, ambient and workplace air — Sampling and analysis of volatile organic compounds by sorbent tube/thermal desorption/capillary gas chromatography*

— *Part 1: Pumped sampling*

— *Part 2: Diffusive sampling*

Indoor air —

Part 2:
Sampling strategy for formaldehyde

1 Scope

This part of ISO 16000 is intended as an aid to planning formaldehyde indoor pollution measurements. In the case of indoor air measurements[1] , the careful planning of sampling and the entire measurement strategy are of particular significance, since the result of the measurement can have far-reaching consequences, for example, with regard to the need for remedial action or the success of such an action.

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 Guide to the expression of uncertainty in measurement (GUM), published jointly by BIPM/IEC/IFCC/ISO/IUPAC/IUPAP/OIML, first edition 1995

ISO 6879:1995, *Air quality — Performance characteristics and related concepts for air quality measuring methods*

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

ISO 16000-4, *Indoor air — Part 4: Determination of formaldehyde — Diffusive sampling method*

3 Sources and occurrence of formaldehyde

The occurrence of formaldehyde in indoor air is often due to the use of certain wood-based board material for construction and for work on the interior and furnishing of a room. Increased concentrations may also be caused by other products, including use of certain disinfectants and paints. Tobacco smoke is an additional important intermittent source of formaldehyde. Details are given in Table B.1.

Whereas an intermittent emission source (e.g. the use for a limited period of time of disinfectant spray containing formaldehyde) will cause an increased formaldehyde concentration in indoor air for only a short period of time during and after use, a continuous emission source (e. g. a particleboard used for indoor furnishings) will contribute to the formaldehyde concentration over a longer period. Figure 1 shows the influence of humidity and temperature on the emission rate of formaldehyde from particleboard; by increasing humidity and temperature, formaldehyde emission increases considerably.

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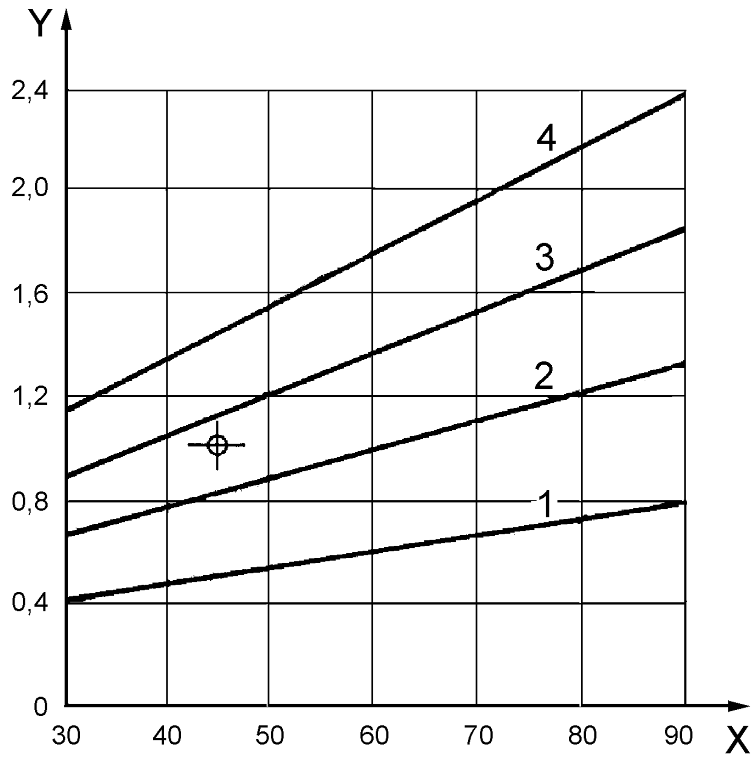
1) This part of ISO 16000 uses the definition for indoor environment [2], [3] defined in ISO 16000-1.



Key

X relative humidity, H, in percent
Y factor K

1 temperature = 15 °C
2 temperature = 20 °C
3 temperature = 25 °C
4 temperature = 30 °C

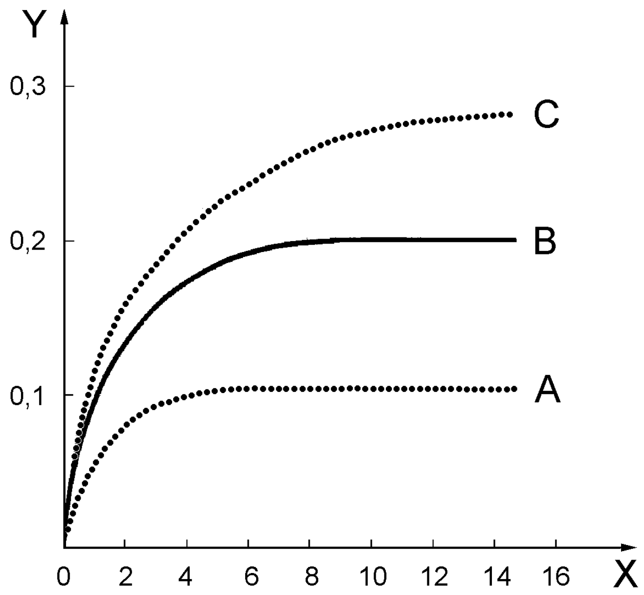
NOTE 1 Parameter for $K = 1$: temperature, 23 °C; relative humidity, 45 %; air exchange rate, 1 h^{-1}; loading, 1 m^2/m^3.

NOTE 2 $C_{t/H} = C_{23/45} \cdot K$, expressed in millilitres per cubic metre (ppm).

Figure 1 — Plot of rate of emission of formaldehyde from particleboards in relation to temperature and relative humidity[1], [4]

Figure 2 presents the formaldehyde equilibration concentration as a function of the air exchange rate after placing a 23-m^2 particleboard emitting 2,3 mg/h formaldehyde into a room of 23 m^3[1], [5]. Curves A, B and C show the outcome with ventilation rates of > 0,5 h^{-1}, 0,5 h^{-1} and < 0,5 h^{-1}, respectively.

The recommended World Health Organization (WHO) guideline value for formaldehyde for indoor/ambient air quality is 0,1 mg/m^3, expressed as the 30 min average concentration[6].



Key

X time, expressed in hours

Y formaldehyde concentration, expressed in milligrams per cubic metre

A ventilation rate $> 0,5\ h^{-1}$

B ventilation rate $= 0,5\ h^{-1}$

C ventilation rate $< 0,5\ h^{-1}$

Figure 2 — Formaldehyde equilibration concentration in relation to the ventilation rate

Generally, outdoor sources of formaldehyde are not significant sources of formaldehyde in indoor air. Outdoor air may be contributory only if strong formaldehyde sources (e.g. heavy road traffic) are nearby.

In a study of 300 typical households in Germany during 1985/86, the median level of formaldehyde in indoor air was found to be 55 µg/m^3[7]. In a few per cent of the cases, concentrations were above 100 µg/m^3. Other, more recent studies in the UK, Sweden and Australia found median formaldehyde concentrations of about 25 µg/m^3 (see Table B.2). Table B.2 compares the median and the range of concentrations measured indoors with concentrations observed in outdoor air.

4 Measurement techniques

4.1 General

There are several methods for measuring formaldehyde. Basically, they meet different demands and can be divided into short-term measurements with active sampling, long-term measurements with active or diffusive samplers, continuous measurements, and screening tests with direct-reading detection tubes. High concentrations of interfering gases (in special cases ozone, NO_2 etc.) shall be taken into account.

Analytical methods for the determination of formaldehyde in the air that can be used to determine compliance with the WHO guideline are described in ISO 16000-3.

4.2 Short-term monitoring

Short-term monitoring is generally conducted for less than one hour.

The method described in ISO 16000-3 is considered to be a multicomponent measurement technique. After formaldehyde reacts with 2,4-dinitrophenylhydrazine to form a hydrazone, it can be determined by HPLC. In addition to formaldehyde, other aldehydes and ketones can also be analysed by this method. This method can be used for checking compliance with the WHO guideline value.

4.3 Long-term monitoring

Long-term monitoring is preferably done with diffusive samplers, described in ISO 16000-4. Sampling relies on the principle of gaseous diffusion into a reactive adsorbent[8], [9], [10], [11], [12]. With diffusive samplers, formaldehyde concentrations are measured over a time period of several hours to a few days. Results are obtained as mean values. If measurement results are necessary for a longer period, repeated measurements shall be performed. The active measurement described in 4.2 is applicable for sampling periods of 24 h or less.

4.4 Methods for screening tests

Screening tests provide an immediate, although not necessarily sufficient, indication of the formaldehyde concentration. Commercially available test tubes and direct-reading diffusive samplers are available that are relatively simple to use and give results that can inform decisions about the need for further measurements. The results of screening tests facilitate the determination on to the extent of further measurements required. In certain cases the screening tests may result that no further measurements are required (see Annex E). A formaldehyde concentration near or above a given guideline value would make it necessary to determine, with the help of measurement techniques described in ISO 16000-3, whether there is compliance with the guideline value, or by how much the value is exceeded.

When using methods for screening tests, the requirements for design of an appropriate strategy shall be considered. Subclause 5.2 refers to the required conditions. Examples of screening tests are given in Annex E.

5 Sampling strategy

5.1 General

The air-measurement technique selected depends on the problem to be solved as well as the nature of the source. Since long-term and continuously emitting surface-area sources are most important, the methods discussed in this International Standard are confined only to these kinds of sources. If intermittent sources, e.g., tobacco smoke, are or have been recently present, they shall be removed before sampling and formaldehyde emitted by them is to be removed by intensive ventilation.

5.2 Objectives of the measurement and conditions

5.2.1 General

Before an indoor air measurement can be carried out, its objective has to be defined clearly. The measurement is usually required because of one of the following objectives:

a) to check compliance with the guideline value;

b) to determine maximum concentrations;

c) to check the efficiency of remediation;

d) to determine the average concentration over a longer period of time.