International Standard

ISO 16000-3

Fourth edition
2026-09

# Indoor air —

## Part 3: Determination of formaldehyde and other carbonyl compounds in indoor air and test chamber air — Active sampling method

*Air intérieur —*

*Partie 3: Dosage du formaldéhyde et d'autres composés carbonylés dans l'air intérieur et dans l'air des chambres d'essai — Méthode par échantillonnage actif*

Reference number
ISO 16000-3:2026(en)

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Published in Switzerland

# Contents

Page

**Foreword** ... **iv**
**Introduction** ... **v**
**1 Scope** ... **1**
**2 Normative references** ... **2**
**3 Terms and definitions** ... **2**
**4 Principle** ... **2**
**5 Limitations and interferences** ... **2**
5.1 General ... 2
5.2 Ozone interference ... 3
**6 Safety measures** ... **4**
**7 Apparatus** ... **5**
7.1 Sampling ... 5
7.2 Sample preparation ... 5
7.3 Sample analysis ... 7
**8 Reagents and materials** ... **7**
**9 Preparation of reagents and cartridges** ... **8**
9.1 Purification of 2,4-dinitrophenylhydrazine ... 8
9.2 Preparation of DNPH formaldehyde derivative ... 9
9.3 Preparation of DNPH formaldehyde standards ... 9
9.4 Preparation of DNPH coated silica gel cartridges ... 9
9.4.1 General ... 9
9.4.2 DNPH coating solution ... 9
9.4.3 Coating of silica gel cartridges ... 10
**10 Procedure** ... **10**
10.1 Sample collection ... 10
10.2 Process blanks ... 12
10.3 Sample analysis ... 12
10.3.1 Sample preparation ... 12
10.3.2 Sample desorption ... 12
10.3.3 HPLC calibration ... 13
10.3.4 HPLC analysis for formaldehyde ... 16
10.3.5 HPLC analysis of other aldehydes and ketones ... 17
**11 Calculations** ... **19**
**12 Performance criteria and quality assurance** ... **20**
12.1 General ... 20
12.2 Standard operating procedures (SOPs) ... 20
12.3 HPLC system performance ... 20
12.4 Sample loss ... 21
12.5 Measurement plan ... 21
**13 Precision and uncertainty** ... **21**
**14 Test report** ... **21**
**Annex A** (informative) **Determination of acrolein** ... **23**
**Annex B** (informative) **Melting points of DNPH carbonyl derivatives** ... **26**
**Annex C** (informative) **Precision and uncertainty** ... **27**
**Bibliography** ... **29**

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# Foreword

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This document was prepared by Technical Committee ISO/TC 146, *Air quality*, Subcommittee SC 6, *Indoor air*.

This fourth edition cancels and replaces the third edition (ISO 16000-3:2022), which has been technically revised.

The main change is as follows: Annex A has been added which provides a suitable method for the determination of acrolein.

A list of all parts in the ISO 16000 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

This document is intended to be used for characterizing indoor air following the sampling strategy specified in ISO 16000-2 [1]. This document applies to 14 aldehydes and ketones. Formaldehyde is the simplest carbonyl compound, with one carbon, one oxygen and two hydrogen atoms. In its monomolecular state, formaldehyde is a colourless, pungent and reactive gas. Formaldehyde has been used in the production of urea-formaldehyde resins, adhesives and insulating foams. Emissions from particle (chip) board and wall insulation are the major sources of formaldehyde in indoor air. As formaldehyde has a high toxic potential, [2] determining its level accurately is key for air quality.

When formaldehyde is collected by passing air through a reactive medium that converts the compound to a derivative of lower vapour pressure is more efficiently retained by the sampler and its level can be easily analysed.

ISO 16017-1 [3], ISO 16017-2 [4], ISO 12219-1 [5] and ISO 12219-5 [6] describe analytical methods for a broader spectrum of volatile organic compounds (VOCs) and can be used if other groups besides carbonyl compounds are to be analyzed.

Instead of systematic International Union of Pure and Applied Chemistry (IUPAC) nomenclature, traditional names are used in this document. Some equivalent names are:

— acetaldehyde for ethanal;

— acetone for 2-propanone;

— butyraldehyde for butanal;

— capronaldehyde for hexanal;

— formaldehyde for methanal;

— isovaleraldehyde for 3-methylbutanal;

— propionaldehyde for propanal;

— m-tolualdehyde for 3-methylbenzaldehyde;

— o-tolualdehyde for 2-methylbenzaldehyde;

— p-tolualdehyde for 4-methylbenzaldehyde;

— valeraldehyde for pentanal.

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# Indoor air —

# Part 3: Determination of formaldehyde and other carbonyl compounds in indoor air and test chamber air — Active sampling method

## 1 Scope

**WARNING — Persons using this document should be familiar with normal laboratory practice. This document does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any national regulatory conditions.**

This document specifies a sampling method to determine the quantity of formaldehyde (HCHO) in the air with the range of approximately 1 $\mu g/m^3$ to 1 $mg/m^3$ in a time-weighted average (TWA) sample, for long-term (1 h to 24 h) and short-term (5 min to 60 min) sampling. This method involves the collection of compounds from air on to adsorbent cartridges coated with 2,4-dinitrophenylhydrazine (DNPH) and subsequent analysis of the hydrazones formed by high performance liquid chromatography (HPLC) with detection by ultraviolet absorption [7][8].

This document can also be applied for the determination of at least 12 other aromatic as well as saturated and unsaturated aliphatic carbonyl compounds (aldehydes and ketones), with modification, such as:

— acetaldehyde;

— acetone;

— benzaldehyde;

— butyraldehyde;

— capronaldehyde;

— 2,5-dimethylbenzaldehyde;

— formaldehyde;

— isovaleraldehyde;

— propionaldehyde;

— m-tolualdehyde;

— *o*-tolualdehyde;

— *p*-tolualdehyde;

— valeraldehyde.

This document does not apply to longer chained or unsaturated carbonyl compounds such as acrolein. An alternative sampling method using sorbent tubes and analysis by thermal desorption using gas chromatography with mass spectrometry (GC-MS) is given in Annex A.

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## 2 Normative references

There are no normative references in this document.

## 3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

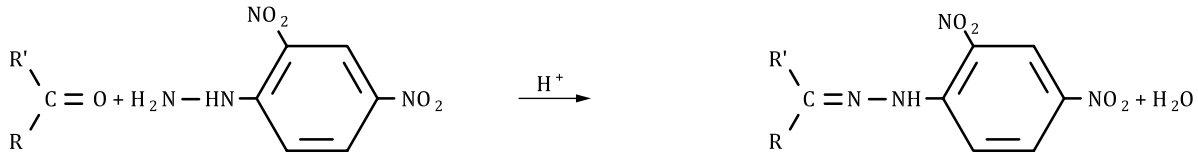
— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

## 4 Principle

The method specified in this document involves the collection of compounds from air on to adsorbent cartridges containing silica gel coated with 2,4-DNPH. The principle of the method is based on the specific reaction of a carbonyl group with DNPH in the presence of an acid to form stable derivatives according to the reaction shown in Figure 1. The DNPH derivatives are analysed for the parent aldehydes and ketones utilizing HPLC with UV detection or diode array detection [7][8]. The detection has been extended to other carbonyl compounds that can be determined as outlined in 10.3.5.

The preparation of sampling cartridges from commercially available chromatographic grade silica gel cartridges by the application of acidified DNPH to each cartridge is covered in this method. If pre-coated DNPH silica gel cartridges are available, they should be used since they are generally more uniform in manufacture and possess lower blank levels. However, if commercial cartridges are used, demonstrate that they meet the performance criteria of this document. An advantage of commercial cartridges is that they are available with larger particle size silica gel – this results in a lower pressure drop across the cartridge. These low pressure drop cartridges can be more suitable for sampling air using battery-powered personal sampling pumps.




Carbonyl compound (aldehyde or ketone) — 2,4-DNPH — DNPH derivative

**Key**

| | |
|---|---|
| R | alkyl group |
| R' | aldehyde or ketone (alkyl group) |

**Figure 1 — Reaction of carbonyl compounds to form 2,4-dinitrophenylhydrazones**

## 5 Limitations and interferences

### 5.1 General

The sampling flow rate specified in this document has been validated for sampling rates up to 1,5 l/min. This flow rate limitation is set principally due to the high pressure drop (>8 kPa at 1,0 l/min) across the user-prepared silica gel cartridges, which have particle sizes of 55 µm to 105 µm. These cartridges are not generally compatible with battery-powered pumps used in personal sampling equipment (e.g. those used by industrial hygienists).

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