



# SLOVENSKI STANDARD

## SIST ISO 4224:2002

01-maj-2002

Ni bUb1'nfU\_!8c`c Yj UbY'c[`1\_cj Y[ Ua cbc\_g]XU!BYX]gdYfn]g\_U]bZUFXY U  
gdY\_lfcZlca Yf]g\_Ua YlcXU

Ambient air - Determination of carbon monoxide - Non-dispersive infrared spectrometric method

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13.040.20      Kakovost okoljskega zraka      Ambient atmospheres

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# INTERNATIONAL STANDARD

**ISO  
4224**

First edition  
2000-03-01

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## Ambient air — Determination of carbon monoxide — Non-dispersive infrared spectrometry method

*Air ambiant — Dosage du monoxyde de carbone — Méthode par  
spectrométrie dans l'infrarouge selon un procédé de type non dispersif*

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Reference number  
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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.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 4224 was prepared by Technical Committee ISO/TC 146, *Air quality*, Subcommittee SC 3, *Ambient air*.

Annexes A, B and C form a normative part of this International Standard.

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## Introduction

Determination of carbon monoxide (CO) is an essential component of the evaluation of many air pollution complexes. Carbon monoxide is formed in the process of incomplete combustion of hydrocarbon fuels, and is a constituent of the exhaust of gasoline engines. Various national air quality regulatory bodies have established air quality standards for CO that are designed to protect the public health and welfare.

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# Ambient air — Determination of carbon monoxide — Non-dispersive infrared spectrometry method

## 1 Scope

This International Standard specifies a non-dispersive infrared spectrometry method for the continuous analysis and recording of the carbon monoxide (CO) content of the ambient air.

The method is applicable to the determination of carbon monoxide concentrations from 0,6 mg/m<sup>3</sup> (0,5 ppm volume fraction) to 115 mg/m<sup>3</sup> (100 ppm volume fraction).

The method has a lower limit of detection of about 0,06 mg/m<sup>3</sup> (0,05 ppm volume fraction) carbon monoxide in air.

## 2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard 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/TR 4227, *Planning of ambient air quality monitoring*.

ISO 6141, *Gas analysis — Requirements on certificates for gases and gas mixtures*.

ISO 6142, *Gas analysis — Preparation of calibration gas mixtures — Gravimetric method*.

ISO 6143, *Gas analysis — Determination of composition of calibration gas mixtures — Comparison methods*.

ISO 6144, *Gas analysis — Preparation of calibration gas mixtures — Static volumetric method*.

ISO 6146, *Gas analysis — Preparation of calibration gas mixtures — Manometric method*.

ISO 6147, *Gas analysis — Preparation of calibration gas mixtures — Saturation method*.

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

ISO 9169, *Air quality — Determination of performance characteristics of measurement methods*.

## 3 Principle

An atmospheric sample is introduced into a sample conditioning system and then into a non-dispersive infrared spectrometer (NDIR).

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The spectrometer measures the absorption by CO at  $4,7\ \mu\text{m}$  [1] using two parallel infrared beams through a sample cell, a reference cell and a selective detector. The detector signal is fed to an amplifier control section and the analyser output measured on a meter and recording system.

Some instruments use gas filter correlation to compare the IR absorption spectrum between the measured gas and other gases present in the sample, in a single sample cell. These instruments utilize a highly concentrated sample of CO as a filter for the IR transmitted through the sample cell, to yield a beam that cannot be further attenuated by the CO in the sample and thus acts as a reference beam. The broadband radiation that passes through the sample cell and the CO filter is filtered again by a narrow-bandpass filter that allows only the CO-sensitive portion of the band to pass to the detector. The removal of wavelengths sensitive to other gases reduces interferences.

The concentration of CO in the sample is determined from a calibration curve [2].

**4 Interferences****4.1 General**

The degree of interference which occurs varies among individual NDIR instruments. Consult the manufacturer's specifications for the particular analyser to determine whether interferences render the instrument unsuitable for the proposed use.

**4.2 Water vapour**

The primary interferant is water vapour, and is a function of the water vapour content in the sample gas. With no correction, the error may be as high as  $11\ \text{mg/m}^3$  (10 ppm volume fraction) [5].

Water vapour interference can be minimized by using one or more of the following procedures:

- a) passing the air sample through a semi-permeable membrane or a similar drying agent;
- b) maintaining a constant humidity in the sample and calibration gases by refrigeration;
- c) saturating the air sample and calibration gases to maintain constant humidity;
- d) using narrow-band optical filters in combination with some of the above measures;
- e) making a volume correction, if the sample is dried or humidified.

**NOTE** Gas-correlation spectrometers facilitate rejection of interference by water vapour, carbon dioxide and organic compounds, therefore use of a narrow-band-pass filter ensures that only the CO-sensitive IR wavelengths are measured.

**4.3 Carbon dioxide**

Interference may be caused by carbon dioxide ( $\text{CO}_2$ ). The effect of  $\text{CO}_2$  interference at concentrations normally present in ambient air is minimal; that is,  $600\ \text{mg/m}^3$  (340 ppm volume fraction) of  $\text{CO}_2$  may give a response equivalent to  $0,2\ \text{mg/m}^3$  (0,2 ppm volume fraction) [3]. If necessary,  $\text{CO}_2$  may be scrubbed with soda lime.

**4.4 Hydrocarbons**

Hydrocarbons at concentrations normally found in the ambient air do not ordinarily interfere; that is,  $325\ \text{mg/m}^3$  (500 ppm volume fraction) of methane may give a response equivalent to  $0,6\ \text{mg/m}^3$  (0,5 ppm volume fraction) [3].

## 5 Apparatus

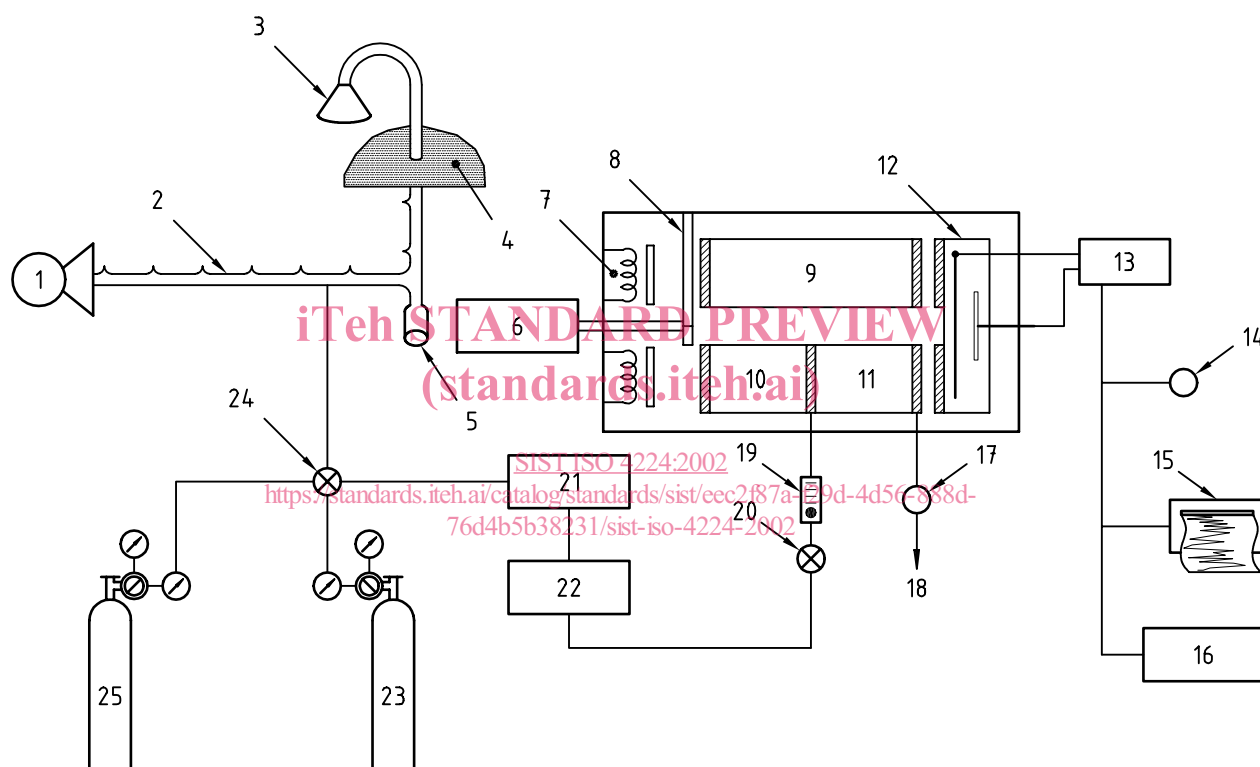
### 5.1 NDIR analyser, for analysis of carbon monoxide in air.

The analyser should be complete with analyser section, sample pump, amplifier/control section, meter, and recording system. The NDIR analyser shall meet the performance specifications described in annex A. See Figure 1.

### 5.2 Sample conditioning system, consisting of flow control valve, rotameter, particulate matter filter, and moisture controller.

### 5.3 Thermometer, capable of measuring atmospheric temperature to $\pm 0,5$ °C.

### 5.4 Barograph or barometer, capable of measuring atmospheric pressure to $\pm 0,6$ kPa.



#### Key

- |                      |                              |
|----------------------|------------------------------|
| 1 Blower             | 14 Analyser readout          |
| 2 Sample manifold    | 15 Strip chart recorder      |
| 3 Sample inlet port  | 16 Data acquisition system   |
| 4 Roof               | 17 Pump                      |
| 5 Moisture trap      | 18 Exhaust                   |
| 6 Motor              | 19 Rotameter                 |
| 7 Infrared source    | 20 Flow control valve        |
| 8 Beam chopper       | 21 Moisture controller       |
| 9 Reference cell     | 22 Particulate matter filter |
| 10 Filter cell       | 23 Span gas                  |
| 11 Sample cell       | 24 Four-way valve            |
| 12 Infrared detector | 25 Zero-air                  |
| 13 Amplifier         |                              |

Figure 1 — Typical carbon monoxide analyser system