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Kakovost zraka - Razsuti materiali - 2. del: Kvantitativno določanje azbesta z gravimetrijsko in mikroskopsko metodo

Air quality - Bulk materials - Part 2: Quantitative determination of asbestos by gravimetric and microscopical methods

Qualité de l'air - Matériaux solides - Partie 2: Dosage quantitatif de l'amiante en utilisant les méthodes gravimétrique et microscopique

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International Standard

ISO 22262-2

Air quality — Bulk materials —

Part 2: Quantitative determination of asbestos by gravimetric and microscopical methods

Qualité de l'air — Matériaux solides —

Partie 2: Dosage quantitatif de l'amiante en utilisant les méthodes gravimétrique et microscopique

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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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 document 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).

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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 3, *Ambient atmospheres*.

This second edition cancels and replaces the first edition (ISO 22262-2:2014), which has been technically revised.

The main changes are as follows:

— procedures for determination of asbestos mass fraction and numerical fibre concentration in talc and other mineral powders have been added;

— an alternate procedure, following gravimetric matrix reduction, for determination of the asbestos mass fraction on filters that exhibit only trace levels of fibres has been added.

A list of all parts in the ISO 22262 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.

Introduction

In the past, asbestos was used in a wide range of products. Materials containing high proportions of asbestos were used in buildings and in industry for fireproofing, thermal insulation and acoustic insulation. Asbestos was also used to reinforce materials, to improve fracture and bending characteristics. A large proportion of the asbestos produced was used in asbestos-cement products. These include flat sheets, tiles and corrugated sheets for roofing, pipes and open troughs for collecting rainwater, and pressure pipes for supplying potable water. Asbestos was also incorporated into products such as decorative coatings and plasters, glues, sealants and resins, floor tiles, gaskets and road paving. In some products asbestos was incorporated to modify rheological properties, for example in the manufacture of ceiling tile panels and oil drilling muds.

Three varieties of asbestos found extensive commercial application. Chrysotile accounted for approximately 95 % of consumption, and therefore this is the variety that is encountered most frequently during analysis of samples. Amosite and crocidolite accounted for almost all of the balance, with a very small contribution from anthophyllite. Amosite was generally used as fireproofing or in thermal insulation products. Crocidolite was also used as fireproofing and thermal insulation products, but because it is highly resistant to acids, it also found application as a reinforcing fibre in acid containers such as those used for lead-acid batteries, and in some gaskets. Materials containing commercial anthophyllite are relatively rare, but it also has been used as a filler and reinforcing fibre in composite materials, and as a filtration medium. Tremolite asbestos and actinolite asbestos were not extensively used commercially, but they sometimes occur as contamination of other commercial minerals. Richterite asbestos and Winchite asbestos occur at mass fractions between 0,01 % and 6 % in vermiculite formerly mined at Libby, Montana, USA. Vermiculite from this source was widely distributed and is often found as loose fill insulation and as a constituent in a range of construction materials and fireproofing.

While the asbestos mass fraction in some products can be very high and in some cases approach 100 %, in other products the mass fractions of asbestos used were significantly lower and often between 1 % and 15 %. In some ceiling tile panels, the mass fraction of asbestos used was close to 1 %. There are only a few known materials in which the asbestos mass fraction used was less than 1 %. Some adhesives, sealing compounds and fillers were manufactured in which asbestos mass fractions were lower than 1 %. There are no known commercially manufactured materials in which any one of the common asbestos varieties (chrysotile, amosite, crocidolite or anthophyllite) was intentionally added at mass fractions lower than 0,1 %.

ISO 22262-1 specifies procedures for collection of samples and qualitative analysis of commercial bulk materials for the presence of asbestos. A visual estimate of the asbestos mass fraction can also be made. While it is recognized that the accuracy and reproducibility of such estimates is very limited, for many of the types of materials being analysed these estimates are sufficient to establish that the mass fraction of asbestos in a manufactured product is, without doubt, well above any of the regulatory limits.

Given the wide range of matrix materials into which asbestos was incorporated, microscopy alone cannot provide reliable analyses of all types of asbestos-containing materials in untreated samples. This document extends the applicability and limit of detection of microscopical analysis by the use of simple procedures such as ashing, acid treatment, sedimentation and heavy liquid density separation prior to microscopical examination. These procedures should be used when the asbestos concentration has been estimated to be very low, by using ISO 22262-1.

This document also specifies procedures for determination of the numerical concentration of mineral fibres in mineral powders such as talc, wollastonite, sepiolite, attapulgite (palygorskite), calcite or dolomite, and commercial products containing these minerals.

A prerequisite for use of this document and subsequent parts of the ISO 22262 series is that the sample first be examined according to ISO 22262-1 by knowledgeable analysts who are familiar with the specified analytical procedures.[7][8][9][10]

Air quality — Bulk materials —

Part 2: Quantitative determination of asbestos by gravimetric and microscopical methods

1 Scope

This document specifies procedures for quantification of asbestos mass fractions below approximately 5 %, and for quantitative determination of asbestos in vermiculite, other industrial minerals and commercial products that incorporate these minerals.

This document is applicable to the quantitative analysis of:

a) any material for which the estimate of asbestos mass fraction obtained using ISO 22262-1 is deemed to be of insufficient precision to reliably classify the regulatory status of the material (i.e. whether the material is subject to asbestos regulations in the particular jurisdiction) or for which it is considered necessary to obtain further evidence to demonstrate the absence of asbestos;

b) resilient floor tiles, asphaltic materials, roofing felts and any other materials in which asbestos is embedded in an organic matrix;

c) wall and ceiling plasters, with or without aggregate;

d) vermiculite and commercial products containing vermiculite;

e) mineral powders such as talc, wollastonite, sepiolite, attapulgite (palygorskite), calcite or dolomite, and commercial products containing these minerals.

This document primarily applies to samples in which asbestos has been identified at estimated mass fractions lower than approximately 5 % by sample mass. This document is also applicable to samples that can contain asbestos at low mass fractions incorporated into matrix material such that microscopical examination of the untreated sample is either not possible or unreliable.

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 13794:2019, *Ambient air — Determination of asbestos fibres — Indirect-transfer transmission electron microscopy method*

ISO 14887, *Sample preparation — Dispersing procedures for powders in liquids*

ISO 22262-1, *Air quality — Bulk materials — Part 1: Sampling and qualitative determination of asbestos in commercial bulk materials*

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
acicular
shape shown by an extremely slender crystal with cross-sectional dimensions which are small relative to its length, i.e. needle-like

[SOURCE: ISO 10312:2019, 3.1]

3.2
amphibole
group of rock-forming ferromagnesium silicate minerals, closely related in crystal form and composition, and having the nominal formula:

$$A_{0\text{-}1}B_2C_5T_8O_{22}(OH,F,Cl)_2$$

where

A	is equal to K, Na;
B	is equal to Fe^{2+}, Mn, Mg, Ca, Na;
C	is equal to Al, Cr, Ti, Fe^{3+}, Mg, Fe^{2+};
T	is equal to Si, Al, Cr, Fe^{3+}, Ti

Note 1 to entry: In some varieties of amphibole, these elements can be partially substituted by Li, Pb or Zn. Amphibole is characterized by a cross-linked double chain of Si-O tetrahedra with a silicon:oxygen ratio of 4:11, by columnar or fibrous prismatic crystals and by good prismatic *cleavage* (3.12) in two directions parallel to the crystal faces and intersecting at angles of about 56° and 124°.

[SOURCE: ISO 10312:2019, 3.2]

3.3
amphibole asbestos
amphibole (3.2) in an *asbestiform* (3.6) *habit* (3.22)

[SOURCE: ISO 10312:2019, 3.3]

3.4
analytical sensitivity
calculated structure concentration equivalent to counting of one structure in the analysis

Note 1 to entry: Analytical sensitivity is expressed in structures per gram.

Note 2 to entry: Analytical sensitivity is applicable to measurements carried out on mineral powders for which the results are reported in terms of the numerical concentration of *fibres* (3.20) per gram.

3.5
anisotropic
state or quality of having different properties along different axes

EXAMPLE An anisotropic transparent particle can show different refractive indices with the vibration direction of incident light.

3.6
asbestiform
specific type of mineral fibrosity in which the *fibres* (3.20) and *fibrils* (3.19) possess high tensile strength and flexibility

[SOURCE: ISO 10312:2019, 3.5]

3.7
asbestos
group of silicate minerals belonging to the *serpentine* (3.32) and *amphibole* (3.2) groups which have crystallized in the *asbestiform* (3.6) *habit* (3.22), causing them to be easily separated into long, thin, flexible, strong *fibres* (3.20) when crushed or processed

Note 1 to entry: The Chemical Abstracts Service Registry Numbers of the most common asbestos varieties are: *chrysotile* (3.11) (12001–29–5), crocidolite (12001–28–4), grunerite asbestos (amosite) (12172–73–5), anthophyllite asbestos (77536–67–5), tremolite asbestos (77536–68–6) and actinolite asbestos (77536–66–4). Other varieties of asbestiform amphibole, such as Richterite asbestos and Winchite asbestos[11], are also found in some products such as vermiculite and talc. CAS Registry Number® is a trademark of the American Chemical Society (ACS). 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.

[SOURCE: ISO 10312:2019, 3.6, modified — in Note 1 to entry, "may" has been changed to "are" in the second sentence, and the third, four and fifth sentences have been added.]

3.8
asbestos point
<point counting> *point* (3.27) that coincides with an *asbestos* (3.7) *fibre* (3.20)

3.9
aspect ratio
ratio of length to width of a particle

[SOURCE: ISO 10312:2019, 3.8]

3.10
birefringence
maximum difference between refractive indices due to double refraction

3.11
chrysotile
fibrous mineral of the *serpentine* (3.32) group which has the nominal composition:

$Mg_3Si_2O_5(OH)_4$

Note 1 to entry: Most natural chrysotile deviates little from this nominal composition. In some varieties of chrysotile, minor substitution of silicon by Al^{3+} can occur. Minor substitution of magnesium by Al^{3+}, Fe^{2+}, Fe^{3+}, Ni^{2+}, Mn^{2+} and Co^{2+} can also be present. Chrysotile is the most prevalent type of *asbestos* (3.7).

[SOURCE: ISO 10312:2019, 3.11, modified — "may" has been changed in two instances to "can" in Note 1 to entry.]

3.12
cleavage
breaking of a mineral along one of its crystallographic directions

[SOURCE: ISO 10312:2019, 3.12]

3.13
cleavage fragment
fragment of a crystal that is bound by *cleavage* (3.12) faces

Note 1 to entry: Crushing of non-asbestiform *amphibole* (3.2) generally yields elongated fragments that conform to the definition of a *fibre* (3.20).

[SOURCE: ISO 10312:2019, 3.13]

3.14
crossed polars
state in which the polarization directions of the *polars* (3.30) (polarizer and analyser) are mutually perpendicular

[SOURCE: ISO 10934:2025, 3.1.124.2]

3.15
dispersion
variation of *refractive index* (3.31) with wavelength of light

[SOURCE: ISO 7348:1992, 05.03.26]

3.16
dispersion staining
effect produced when a transparent object is immersed in a surrounding medium, the *refractive index* (3.31) of which is equal to that of the object at a wavelength in the visible range, but which has a significantly higher optical *dispersion* (3.15) than the object

Note 1 to entry: Only the light refracted at the edges of the object is imaged, and this gives rise to colours at the interface between the object and the surrounding medium. The particular colour is a measure of the wavelength at which the refractive index of the object and that of the medium are equal.

3.17
empty point
<point counting> *point* (3.27) that does not coincide with any particle or *fibre* (3.20)

3.18
energy dispersive X-ray analysis
EDXA
measurement of the energies and intensities of X-rays by use of a solid-state detector and multi-channel analyser system

[SOURCE: ISO 10312:2019, 3.18]

3.19
fibril
single *fibre* (3.20) of *asbestos* (3.7) which cannot be further separated longitudinally into smaller components without losing its fibrous properties or appearances

[SOURCE: ISO 10312:2019, 3.21]

3.20
fibre
elongated particle that has parallel or stepped sides

Note 1 to entry: For the purposes of this document, a fibre has an *aspect ratio* (3.9) equal to or greater than 3:1.

[SOURCE: ISO 10312:2019, 3.22, modified — Note 1 to entry has been replaced.]

3.21
fibre bundle
structure composed of parallel, smaller diameter *fibres* (3.20) attached along their lengths

Note 1 to entry: A fibre bundle can exhibit diverging fibres at one or both ends.

[SOURCE: ISO 10312:2019, 3.23, modified — "may" has been changed to "can" in Note 1 to entry.]

3.22
habit
characteristic crystal growth form, or combination of these forms, of a mineral, including characteristic irregularities

[SOURCE: ISO 10312:2019, 3.25]

3.23
gravimetric matrix reduction
procedure in which constituents of a material are selectively dissolved or otherwise separated, leaving a residue in which any *asbestos* (3.7) present in the original material is concentrated

3.24
isotropic
having the same properties in all directions

[SOURCE: ISO 14686:2003, 2.23]

3.25
matrix
material in a bulk sample within which *fibres* (3.20) are dispersed

3.26
non-empty point
<point counting> *point* (3.27) that coincides with either a particle or an *asbestos* (3.7) *fibre* (3.20)

3.27
point
<point counting> location on the sample where a record is made as to whether the location is occupied by a particle or an *asbestos* (3.7) *fibre* (3.20), or whether the location is unoccupied

3.28
point counting
procedure in which random locations are examined on a sample to determine whether each location is occupied by a particle or an *asbestos* (3.7) *fibre* (3.20), or is unoccupied, and each type of event is enumerated

3.29
polarized light
light in which the vibrations are partially or completely suppressed in certain directions at any given instant

Note 1 to entry: The vector of vibration may describe a linear, circular or elliptical shape.

[SOURCE: ISO 10934:2025, 3.1.93.1]

3.30
polar
device which selects plane-*polarized light* (3.29) from natural light

[SOURCE: ISO 10934:2025, 3.1.124]

3.31
refractive index
n
ratio of the speed of light (more exactly, the phase velocity) in a vacuum to that in a given medium

[SOURCE: ISO 10934:2025, 3.1.131]

3.32
serpentine
group of common rock-forming minerals having the nominal formula:

$Mg_3Si_2O_5(OH)_4$

[SOURCE: ISO 10312:2019, 3.35]

3.33
suspension
heterogeneous system in which a solid is distributed as fine particles in a liquid

[SOURCE: ISO 472:2013, 2.1135]

4 Abbreviated terms

EDXA	energy dispersive X-ray analysis
MEC	mixed esters of cellulose
PC	polycarbonate
PLM	polarized light microscopy
PTFE	polytetrafluoroethylene
SEM	scanning electron microscope
TEM	transmission electron microscope

5 Determination of analytical requirements

Quantification of asbestos beyond the estimate of mass fraction achieved using ISO 22262-1 can be unnecessary, depending on the applicable regulatory limit for definition of an asbestos-containing material, the variety of asbestos identified, and whether the sample can be recognized as a manufactured product. Common regulatory definitions of asbestos-containing materials range from “presence of any asbestos”, to > 0,1 %, and > 0,5 % to > 1 % by mass fraction of one or more of the regulated asbestos varieties. Following the use of ISO 22262-1 on many different samples, an analyst may determine the asbestos mass fraction far exceeds these mass fraction regulatory limits. More precise quantification of asbestos in these types of samples is unnecessary, since a more precise and significantly more expensive determination of the asbestos mass fraction will neither change the regulatory status of the asbestos-containing material nor any subsequent decisions concerning its treatment. Annex A shows a tabulation of most asbestos-containing materials, the variety of asbestos used in these materials and the range of asbestos mass fraction that can be present. Annex A also indicates whether, in general, the estimate of asbestos mass fraction provided by the use of ISO 22262-1 is sufficient to establish the regulatory status of the material, or whether quantification of asbestos by this document is necessary. Use Annex A for guidance on the probable asbestos mass fractions in specific classes of product and to select the optimum analytical procedure to obtain a reliable result.

Asbestos was never deliberately incorporated for any functional purpose into commercially manufactured asbestos-containing materials at mass fractions lower than 0,1 %. Accordingly, if any one or more of the commercial asbestos varieties (chrysotile, amosite, crocidolite or anthophyllite) is detected in a manufactured product, the assumption can be made that asbestos is present in the product at a mass fraction exceeding 0,1 %. Therefore, if the regulatory definition of an asbestos-containing material in a jurisdiction is either “presence of any asbestos” or greater than 0,1 %, then detection of one or more of the commercial asbestos varieties in a recognizable manufactured product automatically defines the regulatory status of the material. If the regulatory definition is either 0,5 % or 1 %, and the mass fraction of asbestos is estimated to be lower than approximately 5 %, then more precise quantification is necessary to guarantee the regulatory status of the material.

Detection of tremolite, actinolite, Richterite or Winchite in a material does not allow any assumptions to be made regarding the asbestos mass fraction, because these asbestos varieties were, in general, not deliberately added to products. Rather, they generally occur as accessory minerals in some of the constituents used to manufacture products. Since the non-asbestiform analogues of the amphiboles are not generally regulated, it is also necessary to discriminate between the asbestiform and non-asbestiform analogues of these minerals. When present, these amphibole minerals often occur as mixtures of the two analogues in industrial minerals.

In the case of talc and some other mineral powders, for some purposes it is necessary to quantify mineral fibres in terms of the numerical concentration of fibres per gram of material, in addition to mass fraction.

It is not possible to specify a single analytical procedure for all types of material that can contain asbestos, because the range of matrices in which the asbestos may be embedded is very diverse. Some materials are amenable to gravimetric matrix reduction, while others are not.

The requirements for quantification of asbestos mass fraction beyond that achieved in ISO 22262-1 are summarized in Table 1.

Table 1 — Summary of requirements for quantification of asbestos mass fraction in bulk samples

<table>
<tr><th rowspan="2">Type of material</th><th colspan="4">Regulatory control limit</th></tr>
<tr><th>“Any asbestos”</th><th>Mass fraction >0,1 %</th><th>Mass fraction >0,5 %</th><th>Mass fraction >1 %</th></tr>
<tr><td>Commercially manufactured product</td><td colspan="2">If any commercial asbestos variety is detected, no further quantification is required.</td><td colspan="2">If asbestos is detected at an estimated mass fraction of <5 %, more precise quantification is required to establish the regulatory status of the material.</td></tr>
<tr><td>Other materials</td><td>If any variety of asbestos is detected, no further quantification is required.</td><td colspan="3">If asbestos is detected at an estimated mass fraction of <5 %, more precise quantification is required to establish the regulatory status of the material.</td></tr>
</table>

6 Range

When this document is applied to a suitably prepared sample analysed by PLM, SEM or TEM, the target range is from less than 0,001 % to 5 %. However, there is no upper limit to the concentration of asbestos that can be determined. The target range for numerical fibre concentration is 10^4 to 10^9 fibres per gram. The lower end of the range for both mass fraction and numerical fibre concentration depends on the proportion of non-asbestos constituents that can be removed by gravimetric methods, the amount of the remaining material that can be examined, and whether the analysis method is PLM, SEM or TEM.

7 Limit of quantification

The limit of quantification using this document is defined as the detection and identification of one fibre or fibre bundle in the amount of sample examined. The limit of quantification that can be achieved depends on:

a) the nature of the matrix of the sample;

b) the size of the asbestos fibres and bundles;

c) the use of appropriate sample preparation and matrix reduction (gravimetric) procedures;

d) the amount of time expended on examination of the sample;

e) the method of analysis used, PLM, SEM or TEM.