



**International
Standard**

ISO 22032

**Water quality — Determination of
polybrominated diphenyl ethers
(PBDE) in sediment, suspended
particulate matter and biota —
Method using gas chromatography
coupled with tandem mass
spectrometry (GC-MS/MS) or with
high resolution mass spectrometry
(GC-HRMS)**

**Second edition
2026-05**

*Qualité de l'eau — Dosage d'éthers diphenyliques polybromés
(PBDE) dans les sédiments, les matières en suspension
(particules) et le biote — Méthode par chromatographie en phase
gazeuse couplée à la spectrométrie de masse en tandem (CG-SM/
SM) ou à la spectrométrie de masse haute résolution (CG-SMHR)*

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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).

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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 147, *Water quality*, Subcommittee SC 2, *Physical, chemical and biochemical methods*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 230, *Water analysis*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 22032:2006), which has been technically revised.

The main changes are as follows:

- the scope has been expanded to include biota;
- GC-MS/MS has been included as a detection method;
- a description of a clean-up set with manual and automated methods for sediment, for suspended particulate matter and biota has been included.

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

This document enables the analysis of polybrominated diphenyl ethers (PBDE) related to 91/271/EEC - the Urban Waste Water Treatment Directive, the European Union directive concerning the collection, treatment and discharge of urban waste water and the treatment and discharge of waste water from certain industrial sectors.

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Water quality — Determination of polybrominated diphenyl ethers (PBDE) in sediment, suspended particulate matter and biota — Method using gas chromatography coupled with tandem mass spectrometry (GC-MS/MS) or with high resolution mass spectrometry (GC-HRMS)

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.

IMPORTANT — It is absolutely essential that tests conducted in accordance with this document be carried out by suitably qualified staff.

1 Scope

This document specifies a method for the determination of selected polybrominated diphenylethers (PBDE) (see [Figure 1](#) and [Table 1](#)) in sediment, suspended particulate matter and biota using gas chromatography coupled with tandem mass spectrometry (GC-MS/MS) or with high resolution mass spectrometry (GC-HRMS) in the electron impact (EI), negative ion chemical ionization (NCI) or atmospheric pressure ionization (APCI) mode.

The method is applicable to sediment and suspended particulate matter samples with limits of quantification of 0,2 µg/kg dry mass (dm) for brominated diphenylether (BDE) BDE-28 to BDE-183, of 2 µg/kg dry mass (dm) for BDE-209.

The method is applicable as well with lower limits of quantification (LOQ), if specific clean-up methods, described in [Clause 10](#), [Table 3](#), method 1 and method 2 in combination with measurement methods GC-MS/MS or GC-HRMS after electron impact ionization (EI) or negative ion chemical ionization (NCI) for BDE-209 are used. Depending on the analytical capability of the instrument, limits of quantification down to 0,003 µg/kg dm for BDE-28 to BDE-154 and 0,02 µg/kg dm for BDE-183 and 1 µg/kg dm for BDE-209 and lower are possible.

The method is applicable to biota samples with limits of quantification down to 0,000 2 µg/kg fresh mass (fm) (BDE-28 to BDE-154) and 0,03 µg/kg fresh mass (fm) (BDE-183), if specific clean-up methods, described in [Table 4](#) in combination with measurement methods GC-MS/MS or GC-HRMS after electron impact ionization (EI) are used.

Performance data are listed in [Annex E](#).

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 8466-1:2021, *Water quality — Calibration and evaluation of analytical methods — Part 1: Linear calibration function*

ISO/TS 13530, *Water quality — Guidance on analytical quality control for chemical and physicochemical water analysis*

EN 16190, *Soil, treated biowaste and sludge — Determination of dioxins and furans and dioxin-like polychlorinated biphenyls by gas chromatography with high resolution mass selective detection (HR GC-MS)*

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

Brominated diphenyl ethers are extracted from dried sample material (sediment, suspended particulate matter, biota) using organic solvents.

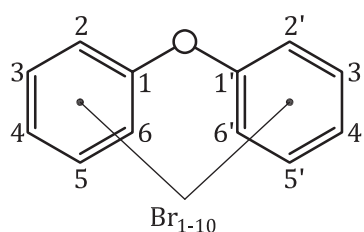


Figure 1 — General structure of polybrominated diphenyl ethers

Table 1 — PBDE congeners determined by this method

No.	Congener	Formula	Abbreviation ^a	CAS-RN ^b	Molar mass g/mol
1	2,4,4'-Tribromodiphenyl ether	C ₁₂ H ₇ Br ₃ O	BDE-28	41318-75-6	406,9
2	2,2',4,4'-Tetrabromodiphenyl ether	C ₁₂ H ₆ Br ₄ O	BDE-47	5436-43-1	485,8
3	2,2',4,4',5-Pentabromodiphenyl ether	C ₁₂ H ₅ Br ₅ O	BDE-99	60348-60-9	564,7
4	2,2',4,4',6-Pentabromodiphenyl ether	C ₁₂ H ₅ Br ₅ O	BDE-100	189084-64-8	564,7
5	2,2',4,4',5,5'-Hexabromodiphenyl ether	C ₁₂ H ₄ Br ₆ O	BDE-153	68631-49-2	643,6
6	2,2',4,4',5,6'-Hexabromodiphenyl ether	C ₁₂ H ₄ Br ₆ O	BDE-154	207122-15-4	643,6
7	2,2',3,4,4',5',6-Heptabromodiphenyl ether	C ₁₂ H ₃ Br ₇ O	BDE-183	207122-16-5	722,5
8	Decabromodiphenyl ether	C ₁₂ Br ₁₀ O	BDE-209	1163-19-5	959,2

^a Numbering analogous to IUPAC nomenclature for Polychlorinated Biphenylethers PCB.

^b Chemical Abstracts Service (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.

Clean-up of the extract is carried out by various methods as specified in this document. Depending on the matrix and the concentration of PBDE in the samples five different clean-up methods for sediment samples and three methods for biota samples can be selected, e.g. column chromatography or gel permeation chromatography. Options for avoiding dichloromethane and toluene in the sample clean-up are available.

After clean-up and concentration, separation of the brominated diphenyl ethers is accomplished by capillary gas chromatography. For detection, different types of GC-MS equipment can be used, applying either mass spectrometry in multiple reaction mode, or high resolution mass spectrometry with different ionisation techniques as electron impact (EI), negative ion chemical ionization (NCI) or atmospheric pressure chemical ionisation (APCI).

For the determination of the analyte concentration in the sample, an internal standard calibration is used.

5 Interferences

Non-specific matrix interferences, as well as interferences from other environmental contaminants are dealt with using the given clean-up procedures.

Sources of contamination of the samples can be the following: brominated diphenyl ethers used as flame-retardants or for other purposes in organic polymers, used in vial covers, Pasteur pipette fillers, recycled paper and are possibly transported also via air dust. Therefore, any contact of samples, reagents or any material used with these organic polymers shall be avoided.

PCB-180 can interfere with BDE-47 if a short column is used. The application of MS/MS detection as well as avoiding m/z 323,87 in the detection by GC-HRMS allows for separation the compounds via mass spectrometry.

Interferences with other chlorinated substances can occur, if chromatographic separation is not sufficient as described in Reference [14]:

- BDE-47 at m/z 323,878 5 with Heptachlorobiphenyl at m/z 323,864 7 such as PCB-180;
- BDE-100 and BDE-99 at m/z 403,787 0 with Octachloronaphthalene at m/z 403,745 0;
- BDE-100 and BDE-99 at m/z 405,784 9 with Heptachlorodibenzofurans at m/z 405,784 7.

MS/MS detection at optional m/z values (see [Table C.1](#)) can solve the problem. Therefore, careful evaluation of instrumentation, masses and mass transitions used in MS shall be done.

Further interferences from BDE-congeners not listed in this document, as well as by other brominated compounds can be found in Reference [15]. Coelutions can occur especially when using short columns and short oven programs. Such potential interferences depending on the analytical column are:

- BDE-16, BDE-33 interfering with BDE-28;
- BDE-184, BDE-182 and BDE-175 interfering with BDE-183.

These and further interferences should be overcome by a sufficient chromatographic separation.

6 Reagents and standards

Use only reagents and materials with negligibly low concentrations of brominated diphenyl ethers, verify this in every analysis series by blank determinations over the total procedure. The blank over the total procedure shall be less than the reported limit of detection (see the definition of the limit of detection in ISO/TS 13530). If necessary, traces of PBDE in solid materials can be reduced by heating at 400 °C.

6.1 Solvents for extraction, preparation of stock solutions and clean-up.

6.1.1 ***n*-Heptane**, C₇H₁₆.

6.1.2 **Toluene**, C₇H₈.

6.1.3 **Acetone (2-propanone)**, C₃H₆O.

6.1.4 **Dichloromethane**, CH₂Cl₂.

6.1.5 **Cyclohexane**, C₆H₁₂.

6.1.6 **Dodecane**, C₁₂H₂₆, for automatized clean-up or as a keeper.