



Designation: D3973 – 85 (Reapproved 2024)

Standard Test Method for Low-Molecular Weight Halogenated Hydrocarbons in Water¹

This standard is issued under the fixed designation D3973; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the analysis of drinking water. It is also applicable to many environmental and waste waters when adequate validation is included.

1.2 This test method covers the determination of halomethanes, haloethanes, and some related extractable organohalides amenable to gas chromatographic measurement. The applicable concentration range for trihalomethanes is from 1 $\mu\text{g/L}$ to 200 $\mu\text{g/L}$. Detection limits depend on the compound, matrix, and on the characteristics of the gas chromatographic system.

1.3 For compounds not specifically included in the precision and bias section the analyst should validate the test method by collecting precision and bias data on actual samples.

1.4 Confirmation of component identities is obtained by observing retention times using gas chromatographic columns of different polarities. When concentrations are sufficiently high (>50 $\mu\text{g/L}$) confirmation with halogen specific detectors or gas chromatography/mass spectrometry (GC/MS) may be used. Confirmation of purgeable compounds at levels down to 1 $\mu\text{g/L}$ can be obtained using Test Method D3871 with GC/MS detection.

1.5 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use. Specific precautionary statements are given in Section 8.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recom-*

mendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Referenced Documents

2.1 *ASTM Standards:*²

D1129 Terminology Relating to Water

D1193 Specification for Reagent Water

D3871 Test Method for Purgeable Organic Compounds in Water Using Headspace Sampling

E355 Practice for Gas Chromatography Terms and Relationships

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this standard, refer to Terminology D1129 and Practice E355.

4. Summary of Test Method

4.1 This test method employs liquid/liquid extraction to isolate compounds of interest and provide a five-fold concentration enhancement prior to measurement.^{3,4,5} A 5 mL aqueous sample is extracted once with 1 mL of solvent. A 3 μL aliquot of the extract is analyzed in a gas chromatograph equipped with an electron-capture detector.

4.2 Extraction efficiencies with the 1:5 solvent/sample ratio for trihalomethanes average above 90 %. To compensate for extraction losses, calibration standards are extracted and analyzed in an identical manner.

4.3 The concentration of each component is calculated and reported in micrograms per litre.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Mieure, J. P., "A Rapid and Sensitive Method for Determining Volatile Organohalides in Water," *Journal AWWA*, Vol 69, 1977, p. 60.

⁴ Richard, J. J., and Junk, G. A., "Liquid Extraction for Rapid Determination of Halomethanes in Water," *Journal AWWA*, Vol 69, 1977, p. 62.

⁵ "The Analysis of Trihalomethanes in Drinking Water by Liquid/Liquid Extraction," U.S. Environmental Protection Agency, EMSL, Cincinnati, OH, Sept. 9, 1977.

¹ This test method is under the jurisdiction of ASTM Committee D19 on Water and is the direct responsibility of Subcommittee D19.06 on Methods for Analysis for Organic Substances in Water.

Current edition approved April 1, 2024. Published April 2024. Originally approved in 1980. Last previous edition approved in 2017 as D3973 – 85 (2017). DOI: 10.1520/D3973-85R24.

5. Significance and Use

5.1 The incidental conversion of organic material to trihalomethanes and other volatile organohalides during chlorination of water is a possible health hazard and is the object of much research. This test method can be used as a rapid, simple means for determining many volatile organohalides in raw and processed water.

6. Interferences

6.1 Volatile compounds that are extractable and responsive to electron-capture detection may interfere with this test method.

6.2 Impurities in the extracting solvent can be a source of interference. Solvent blanks should be analyzed daily and before a new bottle of solvent is used for the first time. Whenever interfering compounds are traced to the solvent, a new source of solvent should be obtained. Alternatively, impurities may be removed by distillation, column chromatography³ or purging with high-purity nitrogen or helium. This procedure is quantitative as long as solvent interference contributes less than 10 % to the component concentration in the sample.

7. Apparatus

7.1 *Extraction Vessel*, 9 mL (2 dram) vial with aluminum foil or PTFE-lined caps.

7.2 *Sample Containers*, 40 mL screw cap vials sealed with PTFE-faced silicone septa.⁶

7.3 *Micro Syringes*, 10, 100 μ L.

7.4 *Pipets*, 1.0 mL and 5.0 mL transfer.

7.5 *Glass-Stoppered Volumetric Flasks*, 10 mL and 100 mL.

7.6 *Gas Chromatograph*, with electron-capture detector.

7.7 *Columns*—Either of the following columns have been found suitable for this analysis. See Fig. 1 for chromatograms. If other column conditions are used, it is up to the analyst to demonstrate the precision and bias statements are met by collecting precision, bias, and recovery data.

7.7.1 *Nonpolar*, 3 mm inside diameter by 2 m long borosilicate glass packed with 100/120 mesh support⁷ coated with a methyl silicone liquid phase⁸ and operated at 60 °C with 45 mL/min carrier flow.

7.7.2 *Polar*, 3 mm inside diameter by 2 m long borosilicate glass packed with 100/120 mesh support⁷ coated with a polar liquid phase such as polyethylene glycol⁹ and operated at 50 °C with 60 mL/min carrier flow.

⁶ 13075 vials and 12722 septa, available from Pierce Chemical Co., P.O. Box 117, Rockford, IL 61105, have been found suitable; other sources that are equivalent may be substituted.

⁷ Gas-Chrom Q, available from Applied Science Laboratory, Inc., P.O. Box 440, State College, PA 16801, has been found suitable; other sources that are equivalent may be substituted.

⁸ OV-101, available from Ohio Valley Specialty Chemical, Inc., Route 6, Marietta, OH 45750, has been found suitable; other sources that are equivalent may be substituted.

⁹ SP-1000, available from Supelco, Inc., Supelco Park, Bellefonte, PA 16823, has been found suitable; other sources that are equivalent may be substituted.

8. Reagents

8.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society,¹⁰ where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

8.2 *Purity of Water*—Unless otherwise indicated, Specification **D1193** reagent water, Type II, will be used in this test method. In addition the water is made organic-free by passing it through a filter bed containing about 0.4 kg of activated carbon (8.3), or using a commercial water purification system.¹¹

8.3 *Activated Carbon*.¹²

8.4 *Dechlorinating Agent*—Granular sodium thiosulfate or ascorbic acid.

8.5 *Detergent*, suitable for laboratory glassware.

8.6 *Isooctane*, pesticide grade.¹³

8.7 *Methyl Alcohol*, pesticide grade.¹⁴

8.8 *Sodium Chloride*, granular.

8.9 *Reference Standards*:

8.9.1 *Bromoform*.

8.9.2 *Bromodichloromethane*.¹⁵

8.9.3 *Chlorodibromomethane*.¹⁶

8.9.4 *Chloroform*.

8.9.5 *Tetrachloroethylene*.

8.9.6 *1,1,1-Trichloroethane*.

8.10 *Stock Solutions*—Prepare a stock solution (2 mg/mL to 10 mg/mL) for each standard as follows:

8.10.1 **Warning**—Because of the toxicity of trihalomethanes it is necessary to prepare primary dilutions in a hood. It is further recommended that a NIOSH/MESA-approved toxic gas respirator be used when the analyst handles high concentrations of such materials.

¹⁰ *ACS Reagent Chemicals, Specifications and Procedures for Reagents and Standard-Grade Reference Materials*, American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmacopeial Convention, Inc. (USPC), Rockville, MD.

¹¹ Super Q water system, available from Millipore Corp. Ashby Rd., Bedford, MA 01730, has been found suitable; other sources that are equivalent may be substituted.

¹² Filtrasorb 200, available from Calgon Corp., Box 1346, Pittsburgh, PA 15230, has been found suitable; other sources that are equivalent may be substituted.

¹³ Pesticide grade, available from Burdick & Jackson Labs, Inc., 1953 S. Harvey St., Muskegon, MI 49442, or Spectro Grade, available from Phillips Chemical Co., Specialty Chemicals, Drawer "O", Borger, TX 79007, have been found suitable; other sources that are equivalent may be substituted.

¹⁴ Pesticide grade, available from Burdick & Jackson Labs, Inc., has been found suitable; other sources which are equivalent may be substituted.

¹⁵ Bromodichloromethane, available from Aldrich Chemical Co., Inc., 940 W. St. Paul Ave., Milwaukee, WI 53233, has been found suitable; other sources that are equivalent may be substituted.

¹⁶ Chlorodibromomethane, available from Chemical Service Inc., 1887 Lincoln Ave., West Chester, PA, has been found suitable; other sources that are equivalent may be substituted.