



Standard Test Method for Determination of Dichloromethane and 1,1,1-Trichloroethane in Paints and Coatings by Direct Injection into a Gas Chromatograph¹

This standard is issued under the fixed designation D4457; 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 determination of total amount of dichloromethane or 1,1,1-trichloroethane, or both, in paints and coatings. It has been evaluated for cellulose nitrate, alkyd, vinyl, and styrene-butadiene systems. It has not yet been evaluated for other formulations, but is believed to be applicable. The established working range of this test method is from 31 to 65 % for 1,1,1-trichloroethane and 32 to 78 % for dichloromethane. There is no reason to believe it will not work outside of these ranges. The presence of 1-propanol in paints and coatings requires the use of a different internal standard. (See also Practice E260.)

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *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 and health practices and determine the applicability of regulatory limitations prior to use.* Specific hazard statements are given in Section 7.

2. Referenced Documents

2.1 ASTM Standards:²

E180 Practice for Determining the Precision of ASTM Methods for Analysis and Testing of Industrial and Specialty Chemicals (Withdrawn 2009)³

E260 Practice for Packed Column Gas Chromatography

¹ This test method is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.21 on Chemical Analysis of Paints and Paint Materials.

Current edition approved July 1, 2014. Published July 2014. Originally approved in 1985. Last previous edition approved in 2008 as D4457 – 02 (2008). DOI: 10.1520/D4457-02R14.

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 The last approved version of this historical standard is referenced on www.astm.org.

3. Summary of Test Method

3.1 Anhydrous 1-propanol (see 10.5) is added as an internal standard to suitable aliquot of the whole paint. The aliquot is then diluted with dimethylformamide and injected onto a gas chromatographic column containing a porous polymer packing that separates dichloromethane and 1,1,1-trichloroethane from other volatile compounds.

4. Significance and Use

4.1 Use of 1,1,1-trichloroethane and dichloromethane, which do not measurably contribute to the atmospheric oxidant level, is a way for industry to meet government or other regulations on volatile organic compounds. This test method is designed to determine the content of these halohydrocarbon solvents in paints and coatings. That content can subsequently be used in calculating the volatile organic compound content of a coating.

5. Apparatus

5.1 *Chromatograph*, any gas-liquid chromatographic instrument equipped with a thermal conductivity detector and capable of being temperature programmed (see Table 1). Optionally, a flame ionization detector may be used if the sample is diluted so that no more than 1000 ppm each of dichloromethane and 1,1,1-trichloroethane is present in the injected specimen.

5.2 *Recorder*, a recording potentiometer with a full-scale deflection of 10 mV, a full-scale response time of 2 s or less, and a maximum noise of ± 0.03 % of full scale.

5.3 *Pre-Column*, 40 in. (100 mm) long by 1/8 in. (3.2 mm) outside diameter stainless steel, packed with glass wool, fitted on the entrance end of the column to retain any nonvolatile materials and minimize sludge buildup in the column.

5.4 *Column*, 4 ft (1.22 m) long by 1/8 in. (3.2 mm) outside diameter stainless steel, packed with 80/100 mesh (150 to 180 μm) porous polymer packing material,⁴ or other suitable material.

⁴ Porapak R, a registered trademark of Waters Associates, Inc., Milford, MA, has been found satisfactory for this purpose.

TABLE 1 Typical Instrument Conditions

Detector	thermal conductivity
Column	4 ft (1.22 m) by 1/8 in. (3.2 mm) outside diameter packed with 80–100 mesh porous polymer packing
Temperature, °C	
Injection port	200
Detector block	250
Column	
Initial	100
Final	230 (for 8 min)
°C/min	8
Carrier gas	helium
Flow rate, mL/min	30
Specimen size, µL	1

5.5 *Liquid Charging Devices*, such as microsyringes of 5-µL or 10-µL capacity, cleaned with acetone or other suitable solvent. Visually inspect for plugs or cracks before and after each injection.

5.6 *Vials*, 25-mL to minimize head space, capable of being septum sealed.⁵

6. Reagents and Materials

6.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests, unless otherwise specified (as in 6.7). 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, where such specifications are available.⁶ Other grades may be used provided it is first ascertained that the reagent is of sufficient high purity to permit its use without lessening the accuracy of the determination.

6.2 *Carrier Gas*, helium of 99.995 % or higher purity. High purity nitrogen may also be used.

6.3 *Dimethylformamide (DMF)*, reagent grade.

6.4 *1-Propanol*, gas chromatography spectrophotometric quality (see 10.5).

6.5 *1,1,1-Trichloroethane* (see 6.7).

6.6 *Dichloromethane* (see 6.7).

6.7 *Halogenated Hydrocarbon Stabilizers*—All commercial grades of these halogenated hydrocarbons contain stabilizers. Either obtain the same solvent used in the coating for use as the standard, or find the type and quantity of stabilizer specified for use in the solvent of interest and add the appropriate quantity to the pure solvent.

7. Hazards

7.1 Dimethylformamide is harmful if inhaled or absorbed through skin. Use only with adequate ventilation. Avoid contact with skin, eyes, and clothing.

⁵ Miniert valves, available from The Pierce Chemical Co., Box 117, Rockford, IL 61105, have been found satisfactory for this purpose.

⁶ *Reagent Chemicals, American Chemical Society Specifications*, 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.

8. Preparation of Apparatus

8.1 *Column Conditioning*—The packed column is installed in the gas chromatographic unit leaving the exit end disconnected from the detector. This will prevent any contamination of the detector with the column bleed. Set the helium flow rate at 30 mL/min if a 1/8 in. (3.2 mm) outside diameter column is used. Purge the column 5 to 10 min before heating. Heat the column from room temperature to 200°C at 5°C/min and hold this temperature for at least 12 h (overnight). At the end of this period of time, heat the column to 240°C at a 5°C/min rate and hold this temperature for several hours. The maximum temperature for this packing is 250°C. Cool the column to 100°C and reheat to 240°C at 5°C/min to observe the column bleed. Optimum conditioning of this column may take several cycles of the heating program before a good recorder baseline is achieved. Conditioning of any column other than that suggested (5.4) should be in accordance with the manufacturer's recommendations.

8.2 Install the column in the chromatograph and use the information in Table 1 as a guide to establish the conditions required to give the desired separation. Allow sufficient time for the instrument to reach equilibrium as indicated by a stable recorder baseline. Adjust the carrier-gas flow to a constant rate. Before each calibration and series of determinations (or daily), condition the column at 200°C for 1 h with carrier-gas flow.

9. Calibration

9.1 *Preparation of Standards*—All standards, as well as samples and blanks, should be at a constant temperature. The given order of ingredient addition should be observed to minimize loss of volatile ingredients.

9.1.1 Weighing to 1.0 mg, add 16.0 g of dimethylformamide to a vial capable of being septum sealed. Add 2.0 g of 1,1,1-trichloroethane, 2.0 g of 1-propanol (see 10.5) and 2.0 g of dichloromethane. Seal the vial with a crimp-on or septum seal.

9.2 Determine the retention time of each component by injecting small amounts either separately or in known mixtures. The components should elute close to the typical retention times given in Table 1 and the chromatograms should closely approximate those shown in Fig. 1.

9.3 The area under each peak of the chromatogram is considered a quantitative measure of the corresponding compound. The relative area is proportional to concentration if the detector responds equally to all the sample components. The response to different components is generally significantly different for both flame ionization and thermal conductivity detectors and especially for flame ionization detectors. This difference in detector response may be corrected by use of relative response factors obtained by injecting and measuring the response of known blends. For precise and accurate determination of the halogenated hydrocarbons inject a 1 µL specimen of the standard in accordance with the preparation in 9.1. Calculate the response factors relative to unity for the halogenated hydrocarbons.

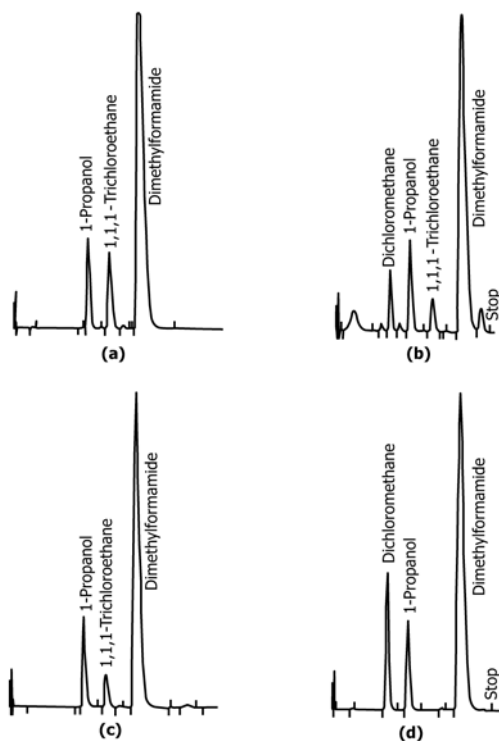


FIG. 1 Typical Chromatograms of Paints

10. Procedure

10.1 Keep all samples, blanks, and standards at a constant temperature. Observe the given order of ingredient addition to minimize loss of volatile ingredients. Shake paints, then sample from the middle of the container.

10.2 Weighing to 1.0 mg, add 16.0 g of dimethylformamide and 5.0 g of the paint to a vial capable of being septum sealed. Add 2.0 g of 1-propanol (see 10.5). Seal the vial with a crimp-on or septum seal.

10.3 Shake the vial. Then to facilitate settling, centrifuge using a low speed centrifuge at 1000 rpm for 5 min.

10.4 Inject a 1- μ L specimen of the supernatant from the prepared solution onto the chromatographic column, in accordance with the conditions established in 8.2. Record the peaks of all components.

10.5 If the composition of the paint is unknown, test for the presence of 1-propanol. Prepare a blank, omitting the 2.0 g of 1-propanol in 10.2, and inject a 1- μ L specimen. To this blank add 2.0 g of 1-propanol and inject a 1- μ L specimen. Then compare peak response to that from the test solution. If 1-propanol is present in the paint, substitute a different internal standard. Other possible internal standards include alcohols, esters, and hydrocarbons.

10.6 If the composition of the paint is unknown, establish whether peaks interfering with 1-propanol or the halogenated

hydrocarbons are present by using both the column specified in 5.4 and a second column that yields different retention times.⁷

11. Calculation

11.1 Measure the area of all peaks (Note 1) and multiply each area by the appropriate attenuation factor to express the peak areas on a common basis.

NOTE 1—Peak areas may be determined by any method that meets the precision requirements of Section 12. Electronic integration is recommended for best results.

11.2 Calculate the percent halogenated hydrocarbon in the paint as follows:

$$RF_i = \frac{W_i}{A_i} \quad (1)$$

where:

RF_i = corrected peak response for i^{th} component, area units,
 W_i = weight of i^{th} component in the standard solution, g,
 and

A_i = chromatographic peak area for the i^{th} component in the standard solution, area units,

then:

$$CH \text{ wt } \% = \frac{RF_{CH} \times A_{CH} \times IS_{amt}}{RF_{IS} \times A_{IS} \times W} \times 100 \quad (2)$$

where:

$CH \text{ wt } \%$ = chlorinated hydrocarbon, weight %,

RF_{CH} = response factor for the chlorinated hydrocarbon in the standard solution, area units,

A_{CH} = area of the chlorinated hydrocarbon peak in the test solution, area units,

IS_{amt} = weight of internal standard added to the paint, g,

RF_{IS} = response factor for the internal standard in the standard solution, area units,

A_{IS} = area of the internal standard peak in the test solution, area units, and

W = specimen weight, g.

12. Precision and Bias⁸ (see also Practice E180)

12.1 Precision:

12.1.1 *1,1,1-Trichloroethane*—On the basis of an interlaboratory test of this test method in which one operator in each of eight laboratories tested three coatings containing from 31 to 65 % 1,1,1-trichloroethane (theoretical), the within-laboratory coefficient of variation was found to be 1.01 % relative at 20 degrees of freedom and the between-laboratories coefficient of

⁷ Packings from the Porapak series and the Chromosorb Century series may be satisfactory for this purpose. However, it is the responsibility of each analyst to check for interferences from paints or the internal standard chosen, or both, and to choose a column that gives symmetrical peaks.

⁸ Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D01-1045. Contact ASTM Customer Service at service@astm.org.

variation was found to be 2.72 % relative at 17 degrees of freedom. Based on these coefficients, the following criteria should be used for judging the acceptability of results at the 95 % confidence level:

12.1.1.1 *Repeatability*—Two results, each the mean of duplicate runs, obtained by the same operator should be considered suspect if they differ by more than 3.0 % relative.

12.1.1.2 *Reproducibility*—Two results, each the mean of duplicate runs, obtained by operators in different laboratories should be considered suspect if they differ by more than 8.1 % relative.

12.1.2 *Dichloromethane*—On the basis of an interlaboratory test of this test method in which one operator in each of eight laboratories tested two coatings containing from 32 to 78 % dichloromethane (theoretical), the within-laboratory coefficient of variation was found to be 0.98 % relative at 14 degrees of freedom and the between-laboratories coefficient of variation was found to be 5.16 % relative at 12 degrees of freedom.

Based on these coefficients, the following criteria should be used for judging the acceptability of results at the 95 % confidence level:

12.1.2.1 *Repeatability*—Two results, each the mean of duplicate runs, obtained by same operator should be considered suspect if they differ by more than 3.0 % relative.

12.1.2.2 *Reproducibility*—Two results, each the mean of duplicate runs, obtained by operators in different laboratories should be considered suspect if they differ by more than 17.92 % relative.

12.2 *Bias*—Bias cannot be determined because there are no standards for dichloromethane and 1,1,1-trichloroethane in paint.

13. Keywords

13.1 chlorinated hydrocarbons in paints by gas chromatograph; dichloromethane, in paints; exempted solvent in paints; gas chromatograph, halohydrocarbon; 1,1,1-trichloroethane, in paints

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org). Permission rights to photocopy the standard may also be secured from the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, Tel: (978) 646-2600; <http://www.copyright.com/>