



Designation: D6284 – 17 (Reapproved 2023)

Standard Test Method for Rubber Property—Effect of Aqueous Solutions with Available Chlorine and Chloramine¹

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1. Scope

1.1 This test method covers procedures for evaluating the ability of rubber and rubber-like materials to withstand the effects of aqueous solutions with available chlorine and chloramine. It is intended to compare the effects of chlorine compounds, present in potable water due to disinfection procedures, on rubber articles.

1.2 Test solutions are designed to contain chlorine compounds, including hypochlorous acid (HOCl), hypochlorite ions (OCl⁻), and monochloramine (NH₂Cl).

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

1.4 *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.*

1.5 *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 Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

- D471 Test Method for Rubber Property—Effect of Liquids
- D1193 Specification for Reagent Water
- D1253 Test Method for Residual Chlorine in Water
- D1415 Test Method for Rubber Property—International Hardness

¹ This test method is under the jurisdiction of ASTM Committee D11 on Rubber and Rubber-like Materials and is the direct responsibility of Subcommittee D11.40 on Consumer Rubber Products.

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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.

- D2240 Test Method for Rubber Property—Durometer Hardness
- D3182 Practice for Rubber—Materials, Equipment, and Procedures for Mixing Standard Compounds and Preparing Standard Vulcanized Sheets
- D3183 Practice for Rubber—Preparation of Pieces for Test Purposes from Products
- D4483 Practice for Evaluating Precision for Test Method Standards in the Rubber and Carbon Black Manufacturing Industries
- D6284 Test Method for Rubber Property—Effect of Aqueous Solutions with Available Chlorine and Chloramine
- D6855 Test Method for Determination of Turbidity Below 5 NTU in Static Mode

3. Terminology

3.1 The terminology of chlorine compounds used in this test method is in accordance with Test Method D1253, Section 7.

3.2 *combined residual chlorine*—residual consisting of chlorine combined with ammonia nitrogen and nitrogenous compounds.

3.3 *free available chlorine residual*—residual consisting of hypochlorite ions (OCl⁻) or hydrochlorous acid (HOCl), or both.

3.4 *total residual chlorine (chlorine residual)*—the amount of available chlorine-induced oxidants present in water at any specified period, subsequent to the addition of chlorine.

4. Summary of Test Method

4.1 This test method provides procedures for exposing test pieces to aqueous available chlorine and chloramine solutions under defined conditions of temperature and time.

4.2 This test method includes the following procedures:

Change in mass after immersion	Section 10
Change in volume after immersion	Section 11
Change in hardness after immersion	Section 12
Visual and turbidity rating after immersion	Section 13

4.3 The resulting deterioration is measured by changes in mass, volume, hardness, and appearance of the test piece surfaces and test liquid after immersion.

4.4 This test method also describes the preparation of the immersion liquids.

5. Significance and Use

5.1 Rubber articles, such as seals, gaskets, and membranes, may be exposed in service to chlorine compounds used in potable water as disinfectants. The exposure may be intermittent or continuous and can occur at various temperatures.

5.2 Properties of rubber articles can deteriorate as a result of exposure to water containing these chlorine compounds, affecting their performance for the intended use.

5.3 This test method attempts to simulate service conditions through controlled accelerated testing, but may not give a direct correlation with part performance under actual service conditions. It yields comparative data on which to base judgement on expected service quality.

5.4 This test method is suitable for compliance testing, quality control, and research and development work.

6. Test Conditions

6.1 *Temperature*—Testing can be performed at room temperature out of direct sunlight. If elevated temperatures are required, testing will be performed in a calibrated oven. Unless otherwise specified between the producer and the purchaser, the preferred test temperature shall be $70\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$.

6.1.1 If the temperature of the testing room is other than the standard $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$, the actual room temperature and any effect on the temperature of the test liquids shall be reported.

6.2 *Immersion Periods*—Unless otherwise specified, the immersion shall be performed in one week intervals depending on the anticipated service conditions. Specific time intervals will be outlined by the customer and then listed in report (refer to 15.1.3).

6.2.1 To obtain a measure on the rate of deterioration, it is necessary to take measurements after several immersion periods. The tolerance of the immersion times shall be $\pm 15\text{ min}$ or $\pm 1\%$ of the specified time, whichever is greater.

7. Apparatus

7.1 An appropriate container able to hold the volume of solution that is no less than 3.13 mL/cm^2 (ratio of media volume per square centimeter of sample).

7.2 Test procedures utilizing continuous monitoring of test liquids and automatic addition of reagents may be used but can be expected to produce different results than those obtained by the procedures of this test method.

7.3 As an alternate option to Test Method D1253, a meter may be used to measure total residual chlorine.³

8. Standard Test Liquids

8.1 Standard test liquids are prepared in amber glass jars of sufficient volume to hold 1900 cm^3 of the liquid.

8.2 Fresh test solutions shall be prepared on a daily basis. At no time throughout the entire test period shall test pieces be allowed to remain in the same solution for more than 48 h.

8.2.1 If the test period is to be 166 h or greater, the test solutions shall be left unchanged for one day per week.

8.3 Total residual chlorine levels of at least one freshly prepared available chlorine and monochloramine solution shall be determined weekly.

8.4 Test solutions are transferred at room temperature unless specified by a specific test protocol to be performed at a higher temperature. If so solutions are heated in loosely sealed amber glass jars in a suitable water bath or hot forced-air oven to $70\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ prior to transferring them into test vessels in accordance with Section 9.

8.4.1 An acceptable alternative method is the use of a glass container of sufficient volume to prepare a large batch of test solution capable of filling all test vessels with 1900 cm^3 of solution each. Prior to filling the test vessels, the liquid shall be stirred and checked with an immersion thermometer to ensure that the specified test temperature has been reached throughout the batch.

8.5 Preparation of Standard Test Liquids and Solutions:

8.5.1 *Reagent Water*—Distilled or deionized water (Type III or purer, see Specification D1193) is heated to the test temperature in a loosely sealed amber glass jar and transferred to the test vessel.

8.5.2 *Available Chlorine and Chloramine Test Solution*—A volume of 1900 cm^3 of distilled or deionized water (Type III or purer, see Specification D1193) is mixed at room temperature in a loosely sealed amber glass jar with 0.9 cm^3 of sodium hypochlorite solution with 10 % minimum total residual chlorine⁴ and 7.0 cm^3 of phosphate buffer solution (pH 7.0) is then added using a graduated pipette. The glass jar is conditioned for $10\text{ min} \pm 1\text{ min}$ at room temperature and the solution tested for total residual chlorine content. Solution strength shall be $50\text{ ppm (mg/L)} \pm 5\text{ ppm (mg/L)}$ of total residual chlorine determined in accordance with Test Method D1253, Section 10 or using the apparatus listed in 7.3. If the solution is not within the required limits, adjust accordingly and retest for total residual chlorine content. The prepared solution is transferred into the test vessels.

8.5.2.1 Chloramine T shall not be used as a replacement for any of the reagents specified in the preparation of the test solutions.

8.5.2.2 Sodium hypochlorite solutions are not stable and will change their concentration in storage. It is therefore recommended to use fresh solutions or store solutions in the dark under refrigeration (about $5\text{ }^{\circ}\text{C}$). The concentration of solutions stored for any length of time should be confirmed by determining their total residual chlorine level in accordance with Test Method D1253, Section 10. If the concentration has

³ The unit produced by Palintest LTD is an example of a meter able to measure both total and free residual chlorine. The “ChloroSense meter” is equipped with ChloroSense sensors and calibration chips. The instructions for proper use of the meter are outlined in the unit’s instructions.

⁴ The sole source of supply of the solution (Catalog No. SS-290) known to the committee at this time is Fisher Scientific, 2000 Park Lane Drive, Pittsburgh, PA 15275. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee.

TABLE 1 Dimensions of Standard Specimens

Type	Length, mm	Width, mm	Thickness, mm
1	50.0 ± 0.1	25.0 ± 0.1	1.0 ± 0.1
2	50.0 ± 0.1	25.0 ± 0.1	2.0 ± 0.1
3	50.0 ± 0.1	25.0 ± 0.1	4.0 ± 0.1

changed, the necessary adjustments shall be made in the preparation of the test solutions.

8.5.3 Monochloramine Test Solution—A volume of 1900 cm³ of distilled or deionized water (Type III or purer, see Specification **D1193**) is mixed at room temperature in a loosely sealed amber glass jar with 0.9 cm³ of sodium hypochlorite solution with 10 % minimum total residual chlorine⁴ and 4.0 cm³ of phosphate buffer solution (pH 7.0) is then added using a graduated pipette. The glass jar is conditioned for 10 min ± 1 min at room temperature followed by the addition of 2.7 cm³ 1 *N* ammonium hydroxide and 8.0 cm³ of phosphate buffer solution⁴ (pH 7.0). The glass jar is conditioned for 10 min ± 1 min at room temperature and the solution tested for total residual chlorine content. Solution strength shall be 50 ppm (mg/L) ± 5 ppm (mg/L) of total residual chlorine determined in accordance with Test Method **D1253**, Section 10 or using the total chlorine probe apparatus listed in **7.3**. If the solution is not within the required limits, adjust accordingly and retest for total residual chlorine content. The prepared solution is transferred into the test vessels.

9. Test Specimens

9.1 Unless otherwise specified, test pieces shall be prepared in accordance with Practice **D3182** or Practice **D3183**.

9.2 Dimensions of standard test pieces shall be as indicated in **Table 1**. Type 2 specimens shall be cut from standard vulcanized sheets prepared in accordance with Practice **D3182**. Sheets for Type 1 and 3 specimens shall be vulcanized in molds modified for cavity depth, but having otherwise the same dimensions as specified in Practice **D3182** (Fig. 1, 2, 3, or 4).

9.3 Type 1 specimens are preferred for accelerated testing. Types 2 and 3 specimens may be specified by mutual agreement between the producer and the purchaser.

9.4 Actual parts may be used as specimens instead of dumbbell specimens if it is requested. If parts are used certain measurement procedures must be adjusted to accommodate the shape and size of the specimen. Durometer will be changed to micro hardness.

9.5 The same test pieces are used to determine changes in mass, volume, hardness, and visual rating.

9.6 If rubber parts or nonstandard test pieces are used, the procedure shall be adjusted to maintain a minimum volume of 20 cm³ of test solutions per 1 cm² of test piece surface area. Data obtained on test pieces of different original thicknesses are not comparable.

10. Procedure for Change in Mass

10.1 See Test Method **D471**, Section 10.

10.2 Test three test pieces of a single composition. Calculate the test results of the three test pieces in accordance with **Eq 1** and average the results.

10.3 Weigh each test piece in air to the nearest 1 mg, record the mass as M_1 , and mount three test pieces on a glass rod so that a minimum of 6 mm separation is maintained between the test pieces through the use of spacers, for example, perforated glass beads. It is important that the materials used to suspend and separate the test pieces do not affect the test liquid and the rubber.

10.4 Place the test piece setup in the test vessel (see **9.1**) containing the test liquid for the specified time and remove each test piece from the flask at the end of the immersion period.

10.5 Cool the test pieces to room temperature by transferring them into a cool and clean portion of the test liquid for 30 min. After removal from the liquid, lightly blot the test pieces dry with lint-free paper, place them in a tared stoppered weighing bottle, weigh each test piece to the nearest 1 mg, record the mass as M_2 .

10.6 Return the test pieces to the cool and clean portion of the test liquid before proceeding with hardness testing and visual rating. After completing all testing return the test pieces to the test vessel with the same test liquid, if data are desired on progressive changes that occur with increasing immersion times.

10.7 It is important that each manipulation following removal of the test pieces from the test liquid takes place promptly with the least possible lapse in time.

10.8 Prepared fresh test liquids daily in accordance with **8.2**, except as described in **2.1**. Discard the old solutions after evaluating turbidity and add fresh solutions to the test vessel (without removal of the test pieces).

11. Procedure for Change in Volume

11.1 See Test Method **D471**, Section 11.

11.2 Test three test pieces of a single composition. Calculate the test results of the three test pieces in accordance with **Eq 2** and average the results.

11.3 Weight each test piece in air to the nearest 1 mg and record the mass as M_1 . Then obtain the mass M_2 of each test piece immersed in distilled water or methanol (**Note 1**) at room temperature.

NOTE 1—Methanol may be employed in place of water if the removal of air bubbles from the test piece surface is a problem.

11.4 Quickly blot the test pieces dry using lint-free paper, mount three test pieces on a glass rod in accordance with **10.3**, and place the test piece setup in the test vessel (see **9.1**) containing the test liquid for the specified time.

11.5 Remove each test piece from the flask at the end of the immersion period and cool to room temperature in a cool and clean portion of the test liquid for 30 min. Lightly blot each test piece dry with lint-free paper, place it in a tared stoppered weighing bottle, weigh to the nearest 1 mg, and record the mass as M_3 . Remove each test piece from the weighing bottle, weigh in distilled water or methanol to the nearest 1 mg, and record the mass as M_4 .