



Designation: F1115 – 16 (Reapproved 2023)

# Standard Test Method for Determining the Carbon Dioxide Loss of Beverage Containers<sup>1</sup>

This standard is issued under the fixed designation F1115; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 The objective of this test method is to determine the carbon dioxide ( $\text{CO}_2$ ) loss from plastic beverage containers after a specified period of storage time.

1.2 Factors contributing to this pressure loss are volume expansion and the gas transport characteristics of the package, including permeation and leakage.

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:*<sup>2</sup>

D1129 Terminology Relating to Water

D1193 Specification for Reagent Water

## 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *automated  $\text{CO}_2$  analyzer*—an electronic unit that will pierce the roll-on closure and automatically read pressure and

temperature and calculate volume of gas (Procedure B). There are multiple manufacturers of these instruments.

3.1.2 *carbonation volume*—the volume of  $\text{CO}_2$  (at 0 °C, 1 atm pressure) that is dissolved in the carbonated water, divided by the volume of the liquid (based on water volume at 3.98 °C equals 1.000 g/cm<sup>3</sup>). The conversion of pressure to carbonation volumes should be made using a carbonation volumes table. A table for carbonated water would not necessarily apply to liquids containing additional substances, such as carbonated beverages containing sugar.

3.1.3 *finish*—the threaded part of the bottle which receives the cap.

3.1.4 *initial pressure*—the equilibrium pressure in the test bottles as measured at 24 h after filling with carbonated water. (The filled bottles are allowed to stand for 24 h to obtain temperature equilibrium with the test environment and to allow time for pressure adjustment and equilibration of the  $\text{CO}_2$  in the headspace and liquid).

3.1.5 *manual pressure tester*—a unit that manually pierces the closure and measures container pressure; an attached thermometer is then used to measure temperature (Procedure B).

3.1.6 *pressure monitoring device*—a pressure gauge or transducer assembly with support electronics for indicating internal pressure level of the bottle. This device is used with brass closure fitting-equipped bottles.

3.1.7 *sample*—a set of bottles produced on the same equipment in a single run and using the same material and process conditions. Bottles should represent normal thickness distribution.

3.1.8 *shelf life*—the number of weeks a sample set of bottles retain a specified carbonation level, or a percent of the initial level.

3.1.9 *support ring*—a protrusion below the bottle finish which is used to support or stabilize the bottle during filling and capping.

3.1.10 *temperature monitoring device*—a thermocouple with support electronics (same equipment as described in 7.2.2). A precision glass thermometer may be used, provided a bottle filled with noncarbonated water is used as a control in each sample set (Procedure A).

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee F02 on Primary Barrier Packaging and is the direct responsibility of Subcommittee F02.10 on Permeation.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3.2 For other terms used in this test method, refer to Terminology D1129.

#### 4. Summary of Test Method

4.1 Test bottles are filled with carbonated water or beverage and, after closure application, are exposed to test environments for specified time periods. By periodically measuring the initial and final carbonation levels in the container, the carbonation loss and carbonation transfer rate can be calculated.

#### 5. Significance and Use

5.1 Two procedures, A and B, are outlined in this test method. Procedure A is used most often for development of various beverage container designs to determine the functional characteristics of the package in regard to shelf life. Procedure B is recommended for use in beverage filling operations as a quality control tool in maintaining the desired CO<sub>2</sub> fill pressure. A loss of CO<sub>2</sub> will affect product taste.

5.1.1 Procedure A involves the use of sensitive pressure and temperature monitoring equipment where a high degree of accuracy is essential, for example, a micro-pressure transducer and thermocouple for measuring pressure and temperature of the package in a closed system. Alternatively, this procedure may also use bottles closed with roll-on aluminum caps containing rubber septums. The septum is pierced with a hypodermic needle attached to a pressure transducer to obtain pressure readings. This procedure should be confined to laboratories that are practiced in this type of analytical testing.

5.1.2 Procedure B is more widely used when measuring the carbonation level of the package due to the simplicity of the technique. A simple Manual pressure assembly or an Automated CO<sub>2</sub> Analyzer is utilized.

#### 6. Interferences

6.1 The following conditions can interfere with the test results:

- 6.1.1 CO<sub>2</sub> leakage at closure due to defective bottle finish or improper sealing of closure apparatus,
- 6.1.2 CO<sub>2</sub> leakage due to improper equipment set-up,
- 6.1.3 Change in ambient temperature, upsetting the equilibrium of the headspace and dissolved CO<sub>2</sub> gas,
- 6.1.4 Measurement of pressure before the bottle and liquid have reached ambient temperature,
- 6.1.5 Inaccurate thermocouple device used for measuring the liquid temperature,
- 6.1.6 Excessive air in the bottle headspace or dissolved in the liquid,
- 6.1.7 Inaccurate or erratic pressure monitoring device,
- 6.1.8 Ambient humidity in the test area,
- 6.1.9 Age of bottles, and
- 6.1.10 Excessive bottle-to-bottle variation in the material distribution, which may result in a wide variation from bottle to bottle within the sample population.

#### 7. Apparatus

- 7.1 *Procedures A and B:*
  - 7.1.1 *Bottle Stand*, optional.
  - 7.1.2 *Height Measuring Device*, capable of measuring to within 0.001 in. (optional).

7.1.3 *Top Loading Balance*, capable of weighing to 2500 g with an accuracy of  $\pm 0.01$  g (optional).

7.1.4 *Outside Diameter Measuring Device*,  $\pi$  tape or similar device (optional).

7.1.5 *Carbonated Water or Beverage Dispensing Equipment*.

7.1.6 *Micrometer or Ultrasonic Thickness Gauge*, capable of measuring to within 0.001 in. or less (optional).

7.2 *Procedure A:*

7.2.1 *Machined Metal Cap* (see Fig. 1).

7.2.2 *Temperature-Measuring Device*, capable of accurately measuring temperature in increments of 0.1 °C or less in a range from 18 °C to 32 °C (65 °F to 100 °F).

7.2.3 *Pressure-Monitoring Device*.

7.2.4 *Fillpoint-Level Syringe Assembly* (see Fig. 2).

7.3 *Procedure B:*

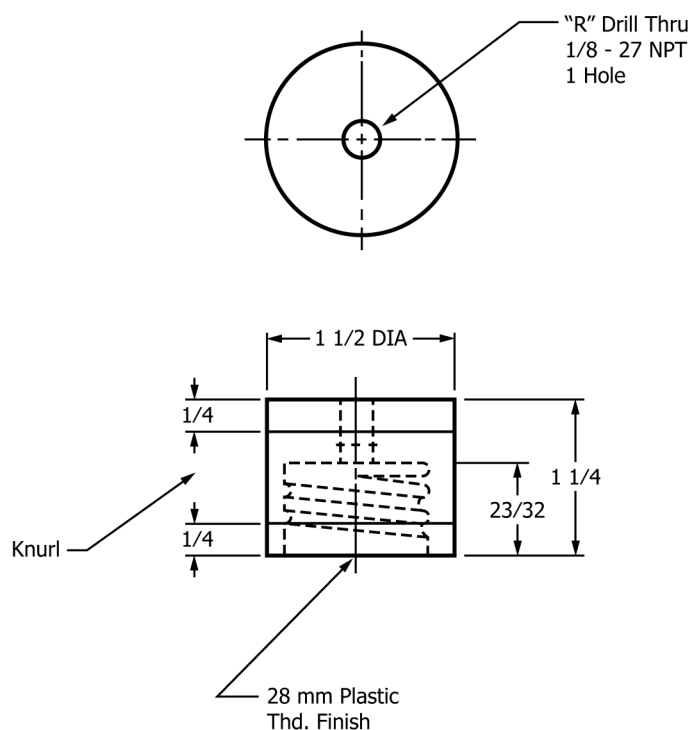
7.3.1 *Pressure- and Temperature-Measuring Device*.

#### 8. Reagents and Materials

8.1 Water carbonated to a level sufficient to ensure a minimum carbonation level of 4.5 volumes in the filled bottles. Reagent water conforming to Type IV of Specification D1193 or better shall be used.

8.2 *Carbon Dioxide*, compressed (CO<sub>2</sub>).

8.3 *Leak-Detecting Solution*.



NOTE 1—Break sharp edges. All dimensions are inches unless otherwise stated. If conversion of dimension is desired, use standard equivalence table.

Material: Brass.

FIG. 1 Machined Metal Cap for PET Beverage Bottle Testing