



Designation: **D4373–14** **D4373 – 21**

## Standard Test Method for Rapid Determination of Carbonate Content of Soils<sup>1</sup>

This standard is issued under the fixed designation D4373; 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 This test method covers the determination of carbonate content of soils and soft rock which can be readily broken down by mechanical effort. It is a gasometric method that uses a simple portable apparatus. Results should be clearly stated as the calcite equivalent in percent because different carbonate species cover a wide range of percent calcite equivalent as shown below for a number of carbonates:

Species	Cation	Calcite Equivalent, %
Magnesite	Mg	117.0
Dolomite	Ca, Mg	108.6
Calcite	Ca	100.0
Aragonite	Ca	100.0
Rhodocrosite	Mn	87.1
Siderite	Fe	86.4
Smithsonite	Zn	79.8
Witherite	Ba	50.7
Cerrusite	Pb	37.5

For example, a 100 % dolomite would be expected to yield 108.6 % calcite equivalent while 100 % siderite would yield only 86.4 % calcite equivalent. Calcite and aragonite reactions will typically complete within about 10 minutes. This method does not distinguish between the carbonate species and such determination must be made using quantitative chemical analysis methods such as atomic absorption.

1.2 *Units*—The values stated in SI units are to be regarded as the standard standard. The values given in parentheses are provided for information only and are not considered standard. Reporting of test results in units other than SI shall not be regarded as nonconformance with this standard

1.3 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice **D6026**.

1.3.1 The procedures used to specify how data are collected/recorded or calculated, in this standard are regarded as the industry standard. In addition, they are representative of the significant digits that generally should be retained. The procedures used do not consider material variation, purpose for obtaining the data, special purpose studies, or any considerations for the user's objectives; and it is common practice to increase or reduce significant digits of reported data to be commensurate with these considerations. It is beyond the scope of this standard to consider significant digits used in analytical methods for engineering design.

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee **D18** on Soil and Rock and is the direct responsibility of Subcommittee **D18.06** on Physical-Chemical Interactions of Soil and Rock.

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\*A Summary of Changes section appears at the end of 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. ~~For specific precaution statements, see Section 8.~~*

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>

[C25 Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime](#)

[D653 Terminology Relating to Soil, Rock, and Contained Fluids](#)

[D3042 Test Method for Insoluble Residue in Carbonate Aggregates](#)

[D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction](#)

[D4753 Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing](#)

[D6026 Practice for Using Significant Digits in Geotechnical Data](#)

[E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves](#)

~~[E145 Specification for Gravity-Convection and Forced-Ventilation Ovens](#)~~

## 3. Terminology

3.1 *Definitions*—For definitions of common technical terms used in this standard, refer to Terminology [D653](#).

## 4. Summary of Test Method

4.1 ~~The carbonate content (calcite equivalent) of soil is determined by treating a 1-g dried soil specimen with hydrochloric acid (HCl) in an enclosed A representative sample is oven dried and then pulverized to pass a 0.425 mm (No. 40) or finer sieve. A 1 g specimen is obtained from the representative sample and placed inside the reaction cylinder (reactor). Carbon dioxide (CO<sub>2</sub>) gas is evolved during the reaction between the acid and carbonate fraction of the specimen. This pressure is measured with a suitable pressure gauge, or equivalent pressure-measuring device, that is pre-calibrated with reagent grade calcium carbonate.~~ Hydrochloric acid gas is evolved during the reaction between the acid and carbonate fraction of the specimen. is added to the reactor using a container and the reactor sealed. The reactor is tilted and then shaken to allow the acid to react with the specimen. After the pressure reading has stabilized, the pressure reading is taken. The resulting pressure generated in the closed reactor is proportional (see Fig. 1) to the calcite equivalent of the specimen. This pressure is measured with a suitable pressure gauge, or equivalent pressure-measuring device, that is pre-calibrated with reagent grade calcium carbonate.

## 5. Significance and Use

5.1 This test method is used to determine the presence and quantity of carbonate in a soil or soft rock specimen in terms of the calcite equivalent. The method is generally intended for use as an index of approximate carbonate content to assist with characterizing marine soils, soils, but can be used for other soils and soft rock. Other test methods exist (such as Method [C25](#) and Test Method [D3042](#)) to evaluate calcium carbonate equivalency for purposes of characterizing use of calcareous materials as soil modifiers or agricultural lining materials.

5.1.1 Calcium carbonates (CaCO<sub>3</sub>) are known cementing agents, are water soluble at pH < 7, and are soft on the Mohs' scale compared to other soil minerals.

5.2 This test method has limitations as follows:

5.2.1 If low carbonate contents (calcite equivalents) are measured, the user does not know whether the soil is low in carbonate content or contains cerrusite, witherite, and the like, which are carbonate species whose reactions with hydrochloric acid are either very slow or limited.

5.2.2 Testing times may be extensive (longer than 1 hour) for some carbonate species (such as dolomite) if calcite equivalents within about 1 % are required.

<sup>2</sup> 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.

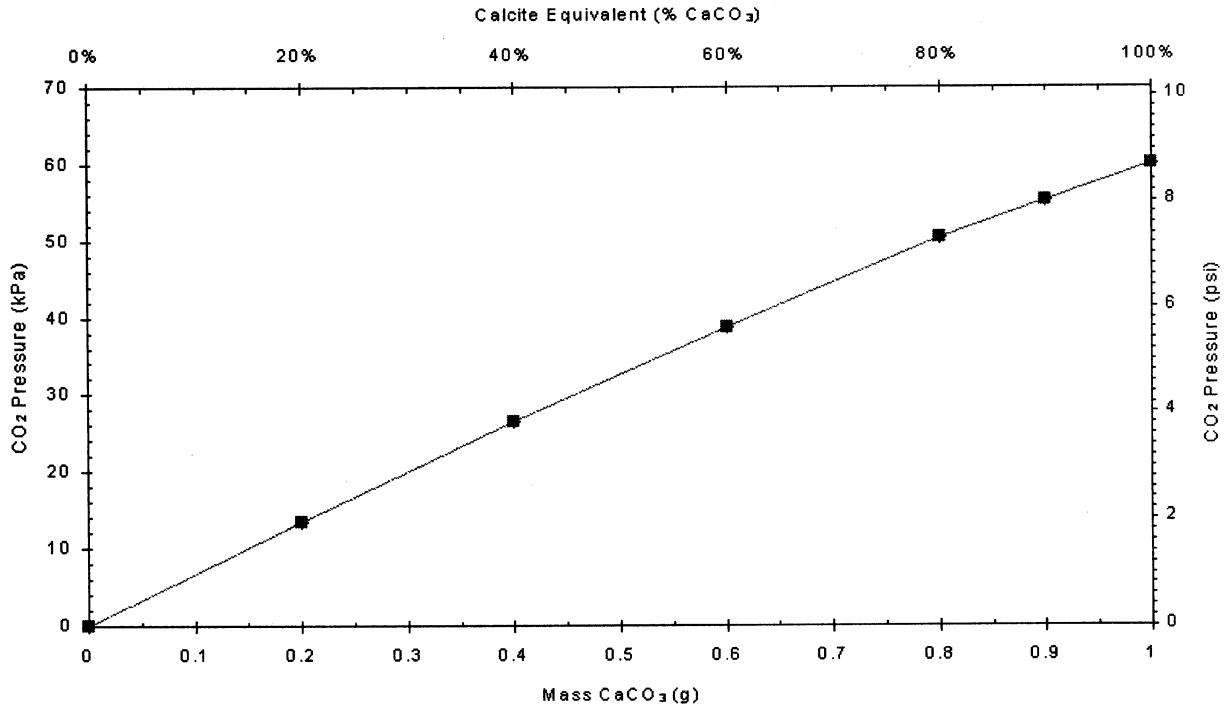


FIG. 12 Typical Calibration Curve for 0.374L (12.6 oz) Test Cell and 70 kPa (10 psi) Pressure Gauge

5.2.3 The effects of specimen grain size, duration of testing, pH and specimen mass are discussed in the literature.<sup>3</sup>

NOTE 1—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D3740 are generally considered capable of competent and objective testing/sampling/inspection, etc. Users of this standard are cautioned that compliance with Practice D3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D3740 provides a means of evaluating some of those factors.

## 6. Apparatus

6.1 *Rapid Carbonate Analyzer*—A schematic drawing of the rapid carbonate analyzer is shown in Fig. 21. The analyzer must be calibrated prior to initial use, after repair, and once every 12 months (Section 10). The basic components of this apparatus include:

6.1.1 *Reaction Cylinder (Reactor), (Reactor)*—with A clear plastic cylinder which allows viewing the effervescent reaction, with a threaded cap and O-ring seal to enclose the cylinder. A clear plastic cylinder allows viewing of effervescent reaction.

6.1.2 *Pressure Gauge (Bourdon Tube-type or Electronic Pressure Transducer), Gauge*—A Bourdon Tube-type or Electronic Pressure Transducer with a capacity of 70 kPa (10 psi), with an accuracy of 0.25%, 1.5%, and a readability of 0.5 kPa (0.1 psi).

6.1.3 *Acid or Soil Container, or Both, Container*—of A clear plastic container with a bail handle to hold 20 mL of acid. Optionally, in addition to, or in place of the acid container, use a soil container of clear plastic to hold the soil/soil/soft rock specimen. Acid added to dry soil often causes considerable splashing and use of soil container reduces splashing before reactor is sealed.

6.1.4 *Pressure Relief Valve, Valve*—Used for safe release of CO<sub>2</sub> gas pressure.

6.2 *Balance*—The balance must meet shall conform to the requirements of Specification Guide D4753 and this section. A Class GP1 balance with a minimum capacity of 100 g and a readability of 0.01 g is required needed to measure the soil/soil/soft rock mass.

<sup>3</sup> Demars, K.R., Chaney, R.C., Richter, J.A., "The Rapid Carbonate Analyzer," *Geotechnical Testing Journal*, ASTM, Vol. 6, No. 1, March 1981, pp. 30–34.

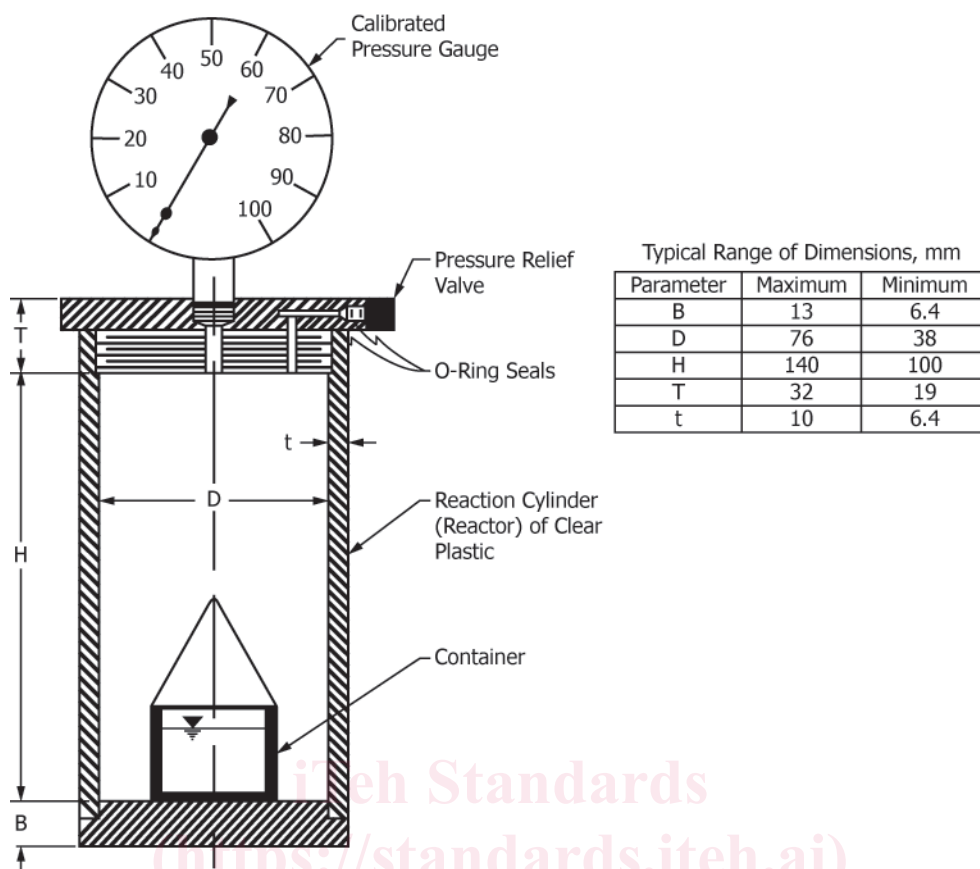


FIG. 21 Schematic Drawing of Rapid Carbonate Analyzer

ASTM D4373-21

<https://standards.iteh.ai/catalog/standards/sist/2d8bb158-ce6b-4e6c-8c5f-b8efaf9c5f9f/astm-d4373-21>

6.3 *Drying Oven, Oven*—thermostatically controlled, preferably of the forced-draft type, meeting the requirements of Specification Vented, thermostatically controlled oven E145 and capable of maintaining a uniform temperature of  $110 \pm 5^\circ\text{C}$   $110 \pm 5^\circ\text{C}$  ( $230 \pm 9^\circ\text{F}$ ) throughout the drying chamber.

6.4 *Sieve*—No. 40 ( $425 \mu\text{m}$ )  $425 \mu\text{m}$  (No. 40) or finer sieve that conforms to the requirements of Specification **E11**.

6.5 *Mortar and Rubber-Covered Pestle (Optional)*—Apparatus suitable for breaking up aggregations of air-dried soil particles without breaking individual particles.

6.6 *Mechanical Agitation Device (Optional)*—A platform, wrist action or similar type shaker having a gyratory, orbital, reciprocating, or similar motion to assist in the reaction process by continuously agitating the soaking soil.

6.7 *Graduated Cylinder, Flask, Pipet, or the Like*—Like—A glass or equivalent inert device with enough capacity to hold  $20 \pm 2$  mL of hydrochloric acid and readable to the nearest 1 mL.

6.8 *Miscellaneous Items*—Items such as a spatula, scoop, or hammer may be useful.