



Designation: D 4373 – 02

Standard Test Method for Rapid Determination of Carbonate Content of Soils¹

This standard is issued under the fixed designation D 4373; 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 carbonate content of soils and soft rock which can be readily broken down by mechanical effort. It is a gasometric method that utilizes 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
Cerussite	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 min. 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 The values stated in SI units are to be regarded as the standard.

1.3 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D 6026.

1.4 The method used to specify how data are collected, calculated, or recorded in this standard is not directly related to the accuracy to which the data can be applied in design or other uses, or both. How one applies the results obtained using this standard is beyond its scope.

1.5 *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 applica-*

bility of regulatory limitations prior to use. For specific precaution statements, see Section 8.

2. Referenced Documents

2.1 ASTM Standards:

C 25 Methods for Chemical Analysis of Limestone, Quicklime and Hydrated Lime²

D 653 Terminology Relating to Soil, Rock, and Contained Fluids³

D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction³

D 4753 Specification for Evaluating, Selecting and Specifying Balances and Scales for Use in Soil, Rock and Construction Materials Testing³

D 6026 Practice for Using Significant Digits in Calculating and Reporting Geotechnical Test Data⁴

E 145 Specification for Gravity-Convection and Forced-Ventilation Ovens⁵

3. Terminology

3.1 For definitions of terms used in this standard see Terminology D 653.

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 reaction cylinder (reactor). Carbon dioxide (CO₂) gas is evolved during the reaction between the acid and carbonate fraction of the specimen. 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 specimen in terms of the calcite equivalent. The method is generally intended for use as an

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² *Annual Book of ASTM Standards*, Vol 04.01.

³ *Annual Book of ASTM Standards*, Vol 04.08.

⁴ *Annual Book of ASTM Standards*, Vol 04.09.

⁵ *Annual Book of ASTM Standards*, Vol 14.04.

*A Summary of Changes section appears at the end of this standard.

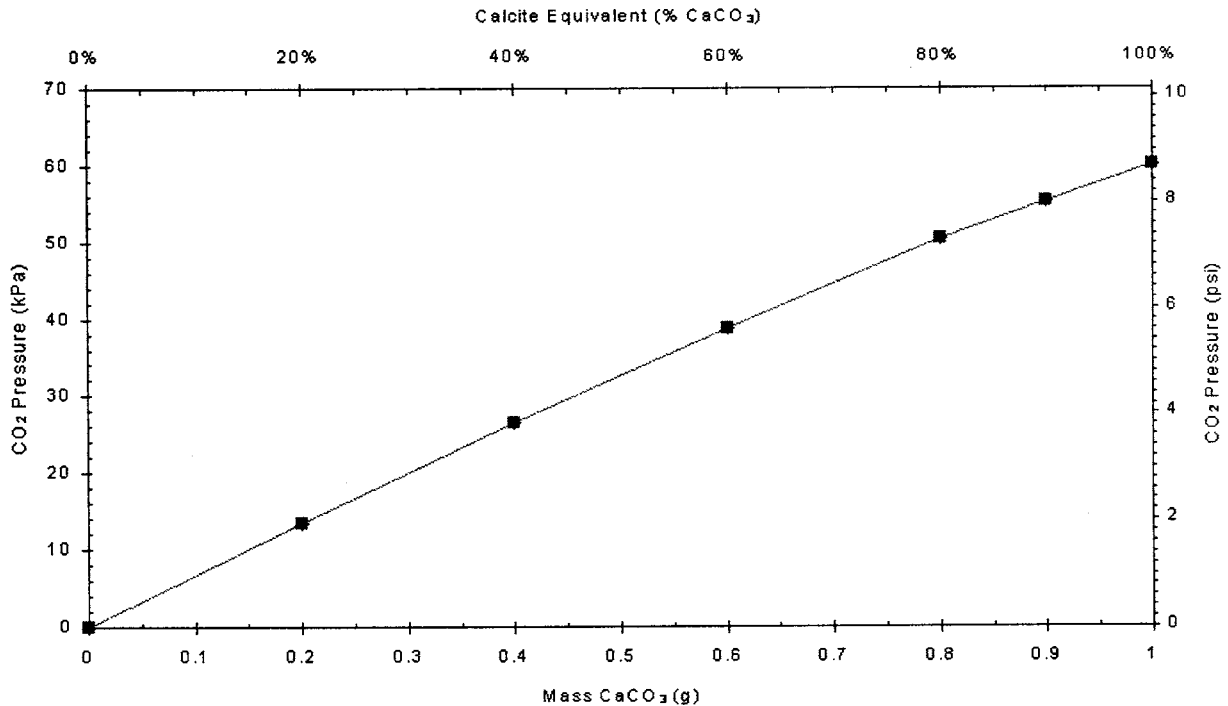


FIG. 1 Typical Calibration Curve for 0.374L Test Cell and 70 kPa (10 psi) Pressure Gauge

index of approximate carbonate content to assist with characterizing marine soils. Other test methods exist (such as Method C 25) 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 (CaCO₃) 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 cerussite, witherite, etc., 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 h) for some carbonate species (such as dolomite) if calcite equivalents within about 1 % are required.

5.2.3 The effects of specimen grain size, duration of testing, pH and specimen mass are discussed in the literature.⁶

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 D 3740 are generally considered capable of competent and objective testing/sampling/inspection, etc. Users of this standard are cautioned that compliance with Practice D 3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D 3740 provides a means of evaluating some of those factors.

⁶ 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.

6. Apparatus

6.1 *Rapid Carbonate Analyzer*—A schematic drawing of the rapid carbonate analyzer is shown in Fig. 2. The basic components of this apparatus include:

6.1.1 *Reaction Cylinder (Reactor)*, with 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)*, 70 kPa (10 psi), with an accuracy of 0.25 %, and a readability of 0.5 kPa (0.1 psi).

6.1.3 *Acid Container*, of clear plastic with a bail handle to hold 20 mL of acid. Optionally, in lieu of the acid container, use a soil container of clear plastic to hold 1 g of soil, with approximate dimensions of 25 mm diameter by 6 mm high with a nominal 4 mm notch down the side of the soil container. 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*, for safe release of CO₂ gas pressure.

6.2 *Balance*—The balance must meet the requirements of Specification D 4753 and this section. A Class GP1 balance with a minimum capacity of 100 g and a readability of 0.01 g is required to measure the soil mass.

6.3 *Drying Oven*, thermostatically-controlled, preferably of the forced-draft type, meeting the requirements of Specification E 145 and capable of maintaining a uniform temperature of 110 ± 5°C throughout the drying chamber.

7. Reagents

7.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that