Designation: C1084 – 19

Standard Test Method for Portland-Cement Content of Hardened Hydraulic-Cement Concrete[1]

This standard is issued under the fixed designation C1084; 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 portland-cement content of a sample of hardened hydraulic-cement concrete.

1.2 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* Disposal of some or all of the chemicals used in this method may require adherence to EPA or other regulatory guidelines.

1.4 *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]

C42/C42M Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
C114 Test Methods for Chemical Analysis of Hydraulic Cement
C670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials
C702 Practice for Reducing Samples of Aggregate to Testing Size
C823 Practice for Examination and Sampling of Hardened Concrete in Constructions
C856 Practice for Petrographic Examination of Hardened Concrete
D1193 Specification for Reagent Water
E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves
E832 Specification for Laboratory Filter Papers

3. Significance and Use

3.1 This test method consists of two independent procedures: an oxide-analysis procedure that consists of two subprocedures and an extraction procedure. Each procedure requires a substantial degree of chemical skill and relatively elaborate chemical instrumentation. Except for the influence of known interferences, determined cement contents are normally equal to, or slightly greater than, actual values except for the Maleic Acid procedure where results can also be significantly low when the paste is carbonated (Note 1).

NOTE 1—With certain limitations, the procedure is also applicable for estimating the combined content of portland cement and pozzolan or slag in concretes made with blended hydraulic cement and blends of portland cement with pozzolans or slags. The results of this test method when applied to concretes made with blended cements or pozzolans depend on the composition of the pozzolan, the age of the concrete, the extent of reaction of the pozzolan and the fact that this test method may determine only the portland-cement component of a blended cement. The test method should be applied to determination of the blended cement content or the pozzolanic content only by use of calibration concrete samples or other information. Earlier versions of this test method can provide useful information as detailed by Hime[3] and Minnick.[4]

4. Interferences

4.1 Many constituents of concrete may interfere with the analysis of the concrete for portland-cement content. The following limited lists of materials have been provided as a

[1] This test method is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.69 on Miscellaneous Tests.

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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.

[3] Hime, W. G., "Cement Content," *Significance of Tests and Properties of Concrete and Concrete-Making Materials, ASTM STP 169B*, ASTM, 1978, pp. 462–470, and "Analyses for Cement and Other Materials in Hardened Concrete," Chapter 29, *Significant of Tests and Properties of Concrete and Concrete-Making Materials, ASTM STP 169C*, 1994, pp. 315–319.

[4] Minnick, L. J., "Cement-Content, Hardened Concrete,"*Significance of Tests and Properties of Concrete and Concrete-Making Materials, ASTM STP 169A*, ASTM, 1966, p. 326–329.

guide. The rocks, minerals or mineral admixtures listed will interfere with the cement content determination to the extent of their solubility during the dissolution procedure used. The solubility of rocks, minerals or mineral admixtures may depend on the fineness of the test sample, the water-cement ratio of the concrete, the extent of hydration, and the age of the concrete (extended exposure to the high pH of the concrete may affect the solubility of some minerals).

4.2 *Substances Affecting Calcium Oxide Sub-procedure:*

4.2.1 The following are soluble in even the cold dilute hydrochloric acid of this procedure and will contribute a high bias to the cement content calculated from the soluble calcium oxide: limestone, marble, dolomitic limestone, calcareous sandstone, calcareous chert, and caliche encrusted and calcite or dolomite coated rocks.

4.2.2 The following may be soluble depending on the age and pH of the concrete; whether the mineral present is glassy or crystalline, or weathered or strained; and the fineness of the mineral present, and, if soluble, will bias the cement content calculated from the soluble calcium oxide high depending on the calcium content of the minerals: weathered or altered plagioclase feldspar, caliche-encrusted rocks, altered volcanic rocks (with calcareous inclusions), and many other calcium containing rocks.

4.2.3 Every percent of soluble calcium oxide that is contributed by soluble aggregate or mineral admixtures will bias the cement content high by approximately 1.6 %.

4.2.4 Silica fume may lower the acid solubility of the sample and hence bias the result low.

4.3 *Substances affecting the Soluble Silica Sub-procedure:*

4.3.1 The following may be soluble depending on the age and pH of the concrete; whether the aggregate is glassy or crystalline, or weathered or strained; and the fineness of the mineral: chert, opal, chalcedony, glassy volcanic rock, strained quartz (highly strained), quartzite, cataclastic rocks (mylonite, phyllonite), gneiss, schist, metagraywacke, and many other soluble silicon containing rocks or minerals.

4.3.2 Every percent of soluble SiO_2 contributed by aggregates or mineral admixtures will bias the reported cement content high by approximately 4.7 %.

4.3.3 Silica fume may lower the acid solubility of the sample and hence bias the result low. If the digestion time or temperature are sufficient to digest all of the portland cement, the silica fume will also be solubilized and bias the calculated cement content high.

4.4 *Substances affecting the Maleic Acid Procedure:*

4.4.1 The same substances that are soluble in the soluble calcium or the soluble silica subprocedures may be soluble in the maleic acid procedure. (See 4.2.1, 4.2.2, and 4.3.1.)

4.4.2 Every 1 % of the sample that is aggregate or mineral admixture dissolved by the maleic acid will bias the cement content high by 1 %.

4.4.3 Carbonated cement paste may not be soluble in the maleic acid-methanol dissolution and thus may bias the cement content results low.

4.4.4 The unhydrated iron and aluminum phases of the portland cement may not be soluble in the maleic acid and, if not soluble, will bias the cement content low. This may be significant at early ages and less significant at later ages.

5. Apparatus

5.1 Choose the apparatus from applicable items given in Test Methods C114 and from the following:

5.1.1 Chipmunk (jaw ore crusher).

5.1.2 Disk Pulverizer.

5.1.3 Rotary Mill (rotating puck).

5.1.4 Sieve, 300 µm (No. 50), 1.18 mm (No. 16), and 4.75 mm (No. 4).

5.1.5 Ice Bath or electric cooling apparatus.

5.1.6 Steam Bath.

5.1.7 Funnel, Buchner-type porcelain funnel.

5.1.8 Filter Paper, Type II, Class F and Class G as described in Specification E832.

5.1.9 Beakers, 1000 mL and 250 mL.

5.1.10 Magnetic stirrer, variable speed, with a TFE-fluorocarbon-coated magnetic stirring rod, or an overhead stirrer with a propeller.

5.1.11 Volumetric flask, 1000 mL and 500 mL.

5.1.12 Filtering flask, 2000 mL.

5.1.13 Vacuum pump.

5.1.14 Watch glass, 125 mm.

6. Reagents and Materials

6.1 *Soluble Silica Sub-procedure:*

6.1.1 *Hydrochloric Acid,* reagent grade, density 1.19 Mg/m^3.

6.1.2 *Hydrochloric Acid (1:3)*—Mix 300 mL of hydrochloric acid into 900 mL of water.

6.1.3 *Hydrochloric Acid (1:9)*—Mix 100 mL of hydrochloric acid into 900 mL of water.

6.1.4 *Sodium Hydroxide (10 g/L)*—Dissolve 5 g of reagent grade sodium hydroxide in 200 mL of water and dilute to 500 mL.

6.1.5 *Hydrofluoric Acid,* 48 %, reagent grade.

6.1.6 *Sulfuric Acid,* density 1.84 g/ml, reagent grade.

6.2 *Calcium Oxide Sub-procedure*—Use reagents as required in Test Methods C114.

6.3 *Maleic Acid Procedure:*

6.3.1 *Maleic acid,* technical grade.

6.3.2 *Methanol,* technical grade, anhydrous.

6.3.3 *Maleic acid solution*—prepare a fresh solution of 15 % maleic acid in methanol by dissolving and diluting 180 + 1 g of maleic acid with methanol to a final solution volume of 1200 mL. Prepare this solution fresh daily. Care must be taken to use methanol only in well ventilated areas, preferably under a hood, to avoid skin contact and breathing vapors. Disposal of the maleic acid/methanol solution shall be according to applicable regulations.

6.3.4 *Fuller's earth*—a clay-like material consisting of a porous colloidal aluminum silicate. Its high adsorptivity has been found very beneficial for decolorizing and purifying materials.

6.4 *Water*—All references to water shall be understood to mean reagent water Types I through IV of Specification D1193.