INTERNATIONAL

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Standard Specification for Processing Additions for Use in the Manufacture of Hydraulic Cements[1]

This standard is issued under the fixed designation C465; 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 specification pertains to the criteria and tests to be used for determining whether a(n) organic or inorganic processing addition, when used in the recommended amount at the option of the cement producer in the manufacture of hydraulic cements, meets the requirements as prescribed by definition in Specifications C150, C1157, C845, and C595. The materials listed in the following former ASTM Specifications shall be considered as meeting the organic processing additions requirements of this specification:

C150 – 62, for Portland Cement
C205 – 58 T, for Portland Blast-Furnace Slag Cement
C340 – 58 T, for Portland Pozzolan Cement
C358 – 58, for Slag Cement

1.2 The following safety hazards caveat pertains only to the test methods described in this specification. *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 applicability of regulatory limitations prior to use.*

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C33 Specification for Concrete Aggregates
C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens
C78 Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
C109/C109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
C114 Test Methods for Chemical Analysis of Hydraulic Cement
C115 Test Method for Fineness of Portland Cement by the Turbidimeter
C138/C138M Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
C143/C143M Test Method for Slump of Hydraulic-Cement Concrete
C150 Specification for Portland Cement
C151 Test Method for Autoclave Expansion of Hydraulic Cement
C173/C173M Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
C185 Test Method for Air Content of Hydraulic Cement Mortar
C187 Test Method for Amount of Water Required for Normal Consistency of Hydraulic Cement Paste
C191 Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle
C192/C192M Practice for Making and Curing Concrete Test Specimens in the Laboratory
C204 Test Methods for Fineness of Hydraulic Cement by Air-Permeability Apparatus
C205 Specification for Portland Blast-Furnace Cement; Replaced by C 595 (Withdrawn 1967)[3]
C226 Specification for Air-Entraining Additions for Use in the Manufacture of Air-Entraining Hydraulic Cement
C231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
C293 Test Method for Flexural Strength of Concrete (Using Simple Beam With Center-Point Loading)

[1] This specification is under the jurisdiction of ASTM Committee C01 on Cement and is the direct responsibility of Subcommittee C01.20 on Additions.

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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] The last approved version of this historical standard is referenced on www.astm.org.

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

C340 Specification for Corkboard Thermal Insulation; Replaced by C 640 (Withdrawn 1967)[3]
C358 Specification for Slag Cement; Replaced by C 595 (Withdrawn 1967)[3]
C595 Specification for Blended Hydraulic Cements
C596 Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement
C617 Practice for Capping Cylindrical Concrete Specimens
C845 Specification for Expansive Hydraulic Cement
C1157 Performance Specification for Hydraulic Cement
D891 Test Methods for Specific Gravity, Apparent, of Liquid Industrial Chemicals
E203 Test Method for Water Using Volumetric Karl Fischer Titration

3. Materials

3.1 *Cements:*

3.1.1 In cases where it is desired that the proposed organic processing addition be accepted for general use in portland cement, tests shall be made on cements prepared from at least five different clinkers. As a minimum, these clinkers shall represent two Type I cements containing not less than 9.0 % C_3A, one Type II cement, and two Type III cements, all conforming to Specification C150.

3.1.2 In cases where it is also desired that the proposed organic processing addition be used in blended cements, the test and test procedures shall be as specified with a control and an addition for cement conforming to the appropriate Specification C595 or C1157.

3.1.3 Organic processing additions which have been shown to meet the requirements of this specification may also be used in cements conforming to Specification C845. Testing of the addition with these special cements, where desired, shall be done using the tests and test procedures as specified with a control cement and a cement containing the addition, both conforming to Specification C845.

3.1.4 In cases where it is desired that the proposed organic processing addition be limited in use to specific types of cement less in number than required in 3.1.1, the tests and test procedures shall be as specified, and at least two pairs of cements shall be prepared from two clinkers from different plants for each type under specific consideration.

3.1.5 For inorganic processing additions, or in cases where it is desired that the proposed organic processing addition be limited in use to a single plant, the tests and test procedures shall be as specified and at least two pairs of cements shall be prepared from clinker representing each type under specific consideration.

3.1.6 The two companion cements to be made from any one clinker shall be ground to the same fineness within 7 m^2/kg when tested in accordance with Test Method C115 or within 13 m^2/kg when tested in accordance with Test Method C204, and the SO_3 content, expressed as a percentage of the cement mass and reported to the nearest 0.01 %, shall differ by not more than 0.3, so as to afford comparable samples for indicating the effect of the addition on the cement. Each control cement shall comply with all requirements in the specification applicable to that type of cement, and shall not contain the proposed addition when tested by the method furnished by the producer or seller of the addition.

NOTE 1—The companion cements for comparison include a sample of the control cement not containing the processing addition and a sample of the cement containing the processing addition.

3.1.7 The percentage of each of the following shall be determined for each lot of cement tested: silicon dioxide (SiO_2), aluminum oxide (Al_2O_3), ferric oxide (Fe_2O_3), calcium oxide (CaO), magnesium oxide (MgO), sulfur trioxide (SO_3), ignition loss, insoluble residue, sodium oxide (Na_2O), and potassium oxide (K_2O). There shall also be calculated the potential percentages of the following compounds: tricalcium silicate, dicalcium silicate, tricalcium aluminate, and tetracalcium aluminoferrite. Determinations for the percentage of the addition shall be made, both on the control cements and on those with which the addition was interground, using the method proposed therefore by the sponsor.

3.2 *Aggregates*—The fine and coarse aggregates shall comply with Specification C33; the coarse aggregate shall comply with the grading requirements for Size No. 57 or Size No. 67. A sufficient quantity from a single lot of coarse aggregate and from a single lot of fine aggregate shall be provided to complete all tests. To prevent the segregation of particle sizes in the fine aggregate, a single lot of sand sufficient for all tests shall either (*1*) be separated on the 4.75-mm (No. 4), 1.18-mm (No. 16), 300 µm (No. 50), and 150 µm (No. 100) sieves and then be recombined in the required quantity for each batch; or (*2*) be blended while in a damp condition, and maintained in that condition for the duration of the tests. Under option (*2*), lots of appropriate size for single mortar and concrete batches shall be carefully split or quartered from the entire batch.

4. General Requirements

4.1 Processing additions shall conform to the respective requirements in this specification.

4.2 The trade name, source, character of the material, and means for the quantitative determination of the addition in the finished cement shall be furnished by the sponsor, manufacturer, or supplier of the addition, and the information shall form a part of the record of tests of the addition. If the processing addition is a liquid, the specific gravity and percent water content shall also be part of the record. If the processing addition is an inorganic solid, the allowable ranges of chemical analysis of the addition shall also be part of the record.

4.2.1 The specific gravity, run in accordance with 7.1.1 shall be within ±0.05 units of the value reported in 4.2.

4.2.2 The chemical analysis in 7.2.1 shall be within the ranges given in 4.2.

4.3 Processing additions shall be evaluated by comparing cements containing the addition to otherwise identical cements from the same source without the addition, or containing a processing addition which has been shown to comply with this specification using control cements without any additions, hereinafter designated the "control" cement.

4.4 The amount of the processing addition to be interground with the cement for evaluation purposes shall be determined by the sponsor of the addition.

4.4.1 The amount of the addition in the cement containing the addition and showing compliance with the requirements of this specification shall be determined quantitatively by means of the quantitative determination required by 4.2.

4.4.2 The amount of addition, so determined, shall be used to state the amount of addition that shows compliance with this specification.

4.4.3 When tests on cements containing the addition show compliance with the requirements of this specification, the addition in cement may be used in any amount up to the maximum amount showing compliance.

4.5 The cement produced for evaluation purposes with the processing addition shall comply with the appropriate Specifications C150, C845, C1157, or C595, except that it contains the addition under test. The effect of the addition on the properties of the cement shall also be within the following limits:

4.5.1 The percentage of water by mass of cement required for normal consistency of cement containing the addition shall not exceed that required by the corresponding control cement by more than 1.0. For those cements not limited to a fixed water requirement, the percentage of water by mass of cement required for standard consistency of the mortar used for strength determinations as described in 4.5.4 shall not be increased by more than 2.0 by the addition over that required for the control cement.

4.5.2 The time of setting of cement containing the addition shall not vary from the time of setting of the corresponding control cement by more than 1 h or 50 %, whichever is the lesser.

4.5.3 The autoclave expansion of cement containing the addition, expressed as a percentage change in length, shall be not more than 0.10 greater than that of the corresponding control cement.

4.5.4 The compressive strength of mortar cubes made with cement containing the addition, in accordance with Test Method C109/C109M, and tested at 1, 3, 7, and 28 days for all types, shall be compared with strengths obtained with the control cement at similar ages. The grand average of these individual strength percentages shall be not less than 95 % of the control cement values. It is required that cubes for companion cements be made and tested on the same days, with storage of specimens side by side in the same section of the moist cabinet during the 24-h curing period. Retesting of companion cements on the same, or a following, day is required in order to provide six, rather than three, test specimens for each cement and age of test.

4.5.5 The ultimate drying shrinkage (percent) of mortar made with cement containing the addition shall not be more than 0.025 greater than that of similar mortar made with the corresponding control cement when tested in accordance with Test Method C596.

4.5.6 The compressive strength of the concrete made with cement containing the addition shall be compared with strengths obtained with the control cement at similar ages. The grand average of these individual strength percentages shall be not less than 90 % of the values for the control cement.

4.5.7 The flexural strength of concrete made with cement containing the addition shall be compared with strengths obtained with the control cement at similar ages. The grand average of these individual strength percentages shall be not less than 90 % of the values for the control cement.

4.5.8 The amount of air-entraining addition required to produce 19 ± 3 % air in the mortar test made in accordance with Test Method C185, with the cement containing the addition under test, shall be not greater than 120 % of the amount required to produce, within ±1 %, the air content obtained with the control cement. The air-entraining addition used shall meet the requirements of Specification C226.

4.6 Processing additions which provide maximum effects as grinding aids or pack set inhibitors may increase cement flowability to a point where mill retention time is reduced sufficiently to affect significantly the particle size distribution of the resulting cement and its physical-chemical properties. Mill retention times are controllable by mechanical means in full-scale grinding mills. Hence, the true physical-chemical effects of the test additive may be determined for acceptance purposes by making supplementary laboratory or pilot-mill grinds, in instances where full-scale tests have shown mill retention time reductions to have significant effects on the properties of the resulting cement.

4.7 In the event that the effect of the addition on the properties of cement are determined on the basis of laboratory or pilot mill grinds, this fact shall be entered in the report specified in Section 13, and the specific tests shall be indicated.

5. Sampling Cement

5.1 Samples of the plant-ground cement shall be taken from the product stream during grinding. Prior to the start of sampling a given lot of cement, the mill shall have run for 4 h or long enough to have reached equilibrium under the general conditions that are to govern during the sampling period.