Standard Test Method for Measurement of Solids in Water[1]

This standard is issued under the fixed designation C 1603; 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 measurement of the solids content in water for use as mixing water in ready-mixed concrete and the measurement of its density. Solids content is expressed in terms of parts per million (ppm) or in terms of percent by mass of the water sample.

1.2 The values stated in SI units are to be regarded as standard; inch-pound units are shown in parenthesis for information only.

1.3 The text of this standard references notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the 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 and health practices and to determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

C 29/ C 29M Test Method for Bulk Density (“Unit Weight”) and Voids in Aggregate

C 670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials

C 1602/C 1602M Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete

3. Significance and Use

3.1 This test method is used to determine the solids content of mixing water used to produce concrete when one or more of the water sources is wash water from concrete production operations or water that contains solids when batched as mixing water in concrete.

3.2 The test method provides a means to determine the relationship between the density and solids content of water for compliance with solids content limits of mixing water such as in Specification C 1602/C 1602M.

3.3 During production of concrete, the water property measured is its density, which can then be used to estimate the solids content from procedures described in this test method.

3.4 To develop a correlation between the density and solids content of water, water samples should be tested that cover the range of solids concentrations anticipated during production.

4. Apparatus

4.1 Density Measure: A cylindrical container (Note 1) with a volume of 200 ± 25 mL (7 ± 1 fl. oz.) with a glass or hard plastic plate that is placed over it. The glass or plastic plate shall be at least 6 mm (¼ in.) thick and 40 mm (1½-in.) larger than the outer diameter of the measure. The top of the density measure shall be flat such that it does not leak when the plate is placed over it.

NOTE 1—A commonly available smaller size mason jar with top ground smooth is acceptable.

4.2 The volume of the density measure shall be determined to nearest 0.1 mL in accordance with procedures used for calibrating air or density measures, as in Test Method C 29/ C 29M.

4.3 A microwave oven with at least 900 W of power capacity.

4.4 A microwave-safe glass dish large enough to contain the water sample and fiberglass cloth (See Note 2).

NOTE 2—A 450 × 450 × 25 mm (9 × 9 × 1 in.) dish is acceptable. Fiberglass cloth commonly used with fiberglass resin for boat or auto body repair is found in most hardware stores.

4.5 A balance or scale with a minimum capacity of 2000 g accurate to 0.1 g

4.6 A rubber syringe

5. Measurement of Density

5.1 Obtain the mass of the empty density measure and plate to the nearest 0.1g.

[1] This test method is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.40 on Ready-Mixed Concrete.

Current edition approved July 1, 2005. Published August 2005. Originally approved in 2004. Last previous edition approved in 2005 as C 1603 – 05.

[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.

5.2 If the water contains solids in suspension, ensure that the water is sampled while the water source is being agitated. Take a representative sample of water and fill the density measure to overflowing. Slide the cover plate over the measure ensuring that there are no air bubbles. Wipe the outside of the plate and measure dry and obtain the mass of the filled density measure covered with the plate.

5.3 Calculate the density of the water sample to 0.001 g/mL

$$D_W = \frac{M_W}{V} \quad (1)$$

Where:

D_W = Density of the water, g/mL,
M_W = Net mass of water in the density measure, g, and
V = Volume of the density measure, mL.

6. Measurement of Solids Content

6.1 Obtain the mass of the empty dish and a piece of fiber glass cloth about 500 mm (20 in.) square to the nearest 0.1 g.

6.2 Keep the glass plate over the density measure and shake the water suspension. Pour the water sample into the glass dish. Using the rubber syringe, wash solids adhered in the measure into the dish using a minimum amount of water. Cover the water with the fiberglass cloth to prevent loss of solids during drying.

6.3 Place the dish in a microwave oven and heat it for approximately 20 min or until the water has evaporated. Determine the mass of the dish and place it back in the microwave oven for 2 min increments until the mass determined in two subsequent determinations do not differ by more than 0.5 g.

6.4 Determine the mass of the dish and cloth with the dried solids.

6.5 Calculate the percent solids in terms of percent by mass to the nearest 0.1 % and in ppm to the nearest 1000 ppm.

$$S_W,\% = \frac{M_s}{M_W} \times 100 \quad (2)$$

$$S_{ppm} = S_W \times 10\,000 \quad (3)$$

Where:

M_s = Mass of dry solids,
M_W = Mass of water with solids,
S_W = Solids content in water, in percent, and
S_{ppm} = Solids content in water, in ppm.

6.6 Repeat these measurements for water with different solids content. Test water at 4 or more different levels of solids content.

7. Relationship Between Density and Solids Content

7.1 Establish a relationship using linear regression analysis (See Note 3) between the measured density and solids content of water sample measurements for a range of solid concentrations that cover the anticipated range in the production facility.

NOTE 3—The linear regression analysis can be performed using spreadsheet software.

7.1.1 Express the relationship between the density of the water and the solids content as follows, such that the measured density on a particular production day can be used to determine the solids content of the water.

$$S_{ppm} = A + B \times D_W \quad (4)$$

Where: A and B are regression constants

NOTE 4—Eq 4 provides an approximate linear relationship between solids content and measured density. The relationship between solids content and density is non-linear (see Eq 5) and Eq 4 should not be used to estimate the solids content of water outside the range of values used to establish the relationship in Eq 4.

NOTE 5—During concrete production, a producer might choose to monitor the density of a water source using a hydrometer. It is recommended that the density of the water using a hydrometer be determined on the water at the time of this density measurement to obtain a relationship, if needed, or to calibrate the hydrometer. The water sample should be placed in a transparent volumetric measuring flask. The hydrometer measurement should be taken within 10 s after filling the water in the flask. This is to ensure that significant settlement of solids has not occurred before the measurement is taken as that will affect the measured density.

7.2 When the relationship between density and solids content is not determined by testing, calculate the solids content of the water in ppm from the measured density using the following:

$$S_{ppm} = \left(\frac{D_W - 1}{D_S - 1}\right) \times \frac{D_S}{D_W} \times 1\,000\,000 \quad (5)$$

where:

D_S = Density of solids in the water, g/mL

7.2.1 When the density of solids in the water is unknown, assume it to be 2.6 g/mL, and determine the solids content of the water in ppm from the measured density using the simplified form of Eq 5 as follows:

$$S_{ppm} = 1\,625\,000 \times \left(1 - \frac{1}{D_W}\right) \quad (6)$$

NOTE 6—Guidance for blending two sources of water with different solids content is provided in Appendix X1.

8. Report

8.1 For the water samples tested to establish the relationship of water density to solids content, maintain a record of the density of water to the nearest 0.001 g/mL; and the solids content of the same water sample in ppm to the nearest 1000 ppm or percent by mass of water to the nearest 0.1 %. Include the dates of these tests and maintain a record of the regression equation used to establish the relationship of water density to solids content.

8.2 For tests of water samples during production of concrete or to calibrate automated measuring devices, maintain a record of water density tests to the nearest 0.001 g/mL or solids content to the nearest 1000 ppm. Include the date and time of these tests. Record the calculated solids content of the tested water sample and the method (7.1 or 7.2) used to determine the solids content.

9. Precision and Bias

9.1 *Precision*—The estimates of precision for this test method are based on results from tests on wash water samples with a range of solids content between 25 000 and 140 000 ppm. Four operators tested the same water samples in triplicate for the density and in duplicate for solids content.

9.1.1 *Single Operator Precision*—The single-operator standard deviation (1s) is shown in Table 1 by average density and solids content; therefore, results of two properly conducted tests on the same sample by the same operator are not expected to differ by more than the d2s values listed in Table 1.

9.1.2 *Multi-Operator Precision*—The multi-operator standard deviation (1s) is shown in Table 1 by average density and solids content; therefore, results of two properly conducted tests on the same sample by two different operators are not expected to differ by more than the d2s values listed in Table 1.

9.2 *Bias*—Since there is no accepted reference material for determining the bias of the results from this test method, no statement on bias is made.

10. Keywords

10.1 concrete mixing water; density; recycled water; solids

TABLE 1 *Table Precision*

	Standard Deviation (1s)[A]	Acceptable Range of Two Results (d2s)[A]
Single Operator Precision		
Density, g/mL		
1.016	0.0005	0.0015
1.033	0.0010	0.0030
1.052	0.0017	0.0047
1.101	0.0014	0.0039
Solids Content, ppm		
22,300	740	2,100
46,600	970	2,700
71,500	600	1,700
134,500	2,300	6,300
Multi-Operator Precision		
Density, g/mL		
1.016	0.0009	0.0026
1.033	0.0018	0.0050
1.052	0.0025	0.0069
1.101	0.0020	0.0056
Solids Content, ppm		
22,300	1,080	3,000
46,600	1,110	3,100
71,500	2,250	6,300
134,500	2,530	7,100

[A]These numbers represent, respectively, the (1s) and (d2s) limits as described in Practice C 670

APPENDIX

(Nonmandatory Information)

X1. Determination of Blending Percentages of Combined Water

X1.1 Use the following relationships to determine the mixing percentage (Note X1.1) of each of two water sources to be blended to ensure that the added mixing water to concrete is at a target limit of solids content or the respective target density.

X1.1.1 When the solids content of the two sources of water is known and water is batched by mass or by volume, use Eq X1.1:

$$P_1 = \frac{S_T - S_2}{S_1 - S_2} \times 100 \quad \text{(X1.1)}$$

X1.1.2 When the density of the two sources of water is known, use Eq X1.2 when water is batched by mass and Eq X1.3 when water is batched by volume:

$$P_1 = \frac{D_T - D_2}{D_1 - D_2} \times \frac{D_1}{D_T} \times 100 \quad \text{(X1.2)}$$

$$P_1 = \frac{D_T - D_2}{D_1 - D_2} \times 100 \quad \text{(X1.3)}$$

Where:

P_1 = Percentage of water from source 1 in the blended mixing water,

S_T and D_T = Target solids content in ppm and density in g/mL of the blended mixing water,

S_1 and D_1 = Solids content in ppm and density in g/mL of the water from source 1, and

S_2 and D_2 = Solids content in ppm and density in g/mL of the water from source 2.

NOTE X1.1—The target solids content may be a limit established in a specification or one that the quality control function of the ready mixed concrete producer establishes. The solids content, typically dissolved, of municipal water may be considered to be 0 ppm and the density may be considered to be 1.0 g/mL, to simplify this calculation.

X1.2 When wash water from concrete production is used at a higher percentage of solids content, there will be necessary corrections in the quantity of mixing water and the volume of solids to account for the solids content in the total mixing water.