



Standard Test Method for Soluble Sulfate in Ceramic Whiteware Clays (Photometric Method)¹

This standard is issued under the fixed designation C867; 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 soluble sulfate ions present in water or a filtrate by means of a photometer measuring the turbidity of precipitated barium sulfate. A method of standardizing the photometer for this test method is also given.

1.2 Soluble sulfate ions may be removed from clays or clay-water slurries by leaching with water during mixing and subsequent filter pressing. To remove all the sulfate ions would require an impractical number of washings; therefore, this test method should be considered a control test and not a quantitative analysis for SO_4 ions.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards*:²

C324 Test Method for Free Moisture in Ceramic Whiteware Clays

D1193 Specification for Reagent Water

2.2 *American Chemical Society Document*:
Specification for Reagent Chemicals³

3. Apparatus

3.1 *Balance*, accurate to 0.0001 g.

3.2 *High-Speed Mixer*.

3.3 *Filter Press*, capable of operating at 690 kPa (100 psi).

3.4 *Glass Beakers*, Erlenmeyer Flasks.

3.5 *Transfer Pipets*.

3.6 *Spectrophotometer* and accessories.

3.7 *Measuring Spoon*, to hold approximately 0.2 g of BaCl_2 or THQ Cup.

3.8 Other usual laboratory equipment, including timers, etc.

4. Reagents

4.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available.⁴ Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

4.2 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean Type IV Grade reagent water as defined in Specification D1193.

4.3 Barium Chloride ($\text{BaCl}_2 \cdot \text{H}_2\text{O}$) crystals, 20 to 30 mesh.

4.4 *Salt-Acid Reagent*—However, it can be prepared from: 23.6 ml HCl, 253.0 gm NaCl, 976.4 ml distilled water. This solution should be stored in an automatic pipettor for accurate measurement.

4.5 *Glycerine Reagent*—a mixture of equal volumes of c. p. glycerine and reagent grade water or it may be purchased from a laboratory supply house. This solution should be stored in an automatic pipettor for accurate measurement.

4.6 *Standard Sulfate Solution*—a solution of c. p. sodium sulfate in reagent grade water at a concentration which contains exactly 100 ppm of sulfate ion.

¹ This test method is under the jurisdiction of ASTM Committee C21 on Ceramic Whitewares and Related Products and is the direct responsibility of Subcommittee C21.04 on Raw Materials.

Current edition approved Jan. 1, 2014. Published February 2014. Originally approved in 1977. Last previous edition approved in 2007 as C867 – 94 (2007). DOI: 10.1520/C0867-94R14.

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 Available from American Chemical Society, 1155 16th Street, NW, Washington, DC 20036.

⁴ *Reagent Chemicals, American Chemical Society Specifications*, American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmaceutical Convention, Inc. (USPC), Rockville, MD.

5. Standardization of Apparatus

5.1 It should be noted that the instrument requires about 30 min to warm up. Keep a blank cell in the instrument when a sample is not in the holder. For SO_4 determination, the filter wavelength should be set at 550 nm.

5.2 Using the appropriate pipettes, measure 25 ml of the standard 100 ppm solution into a 125 ml Erlenmeyer flask. Add 5 ml of glycerine reagent and 2.5 ml of salt-acid reagent and stir thoroughly.

5.3 Fill a clean transmission cell with the prepared solution. Be sure to wipe off any droplets of water or solution on the outside of the cell since this may interfere with the readings.

5.4 Insert the cell into the cell holder. Put the 550 nm filter in place and adjust the transmission to read 100.0 percent.

5.5 Pour the contents of the cell back into the flask and add 1 THQ cupful of $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ crystals. Stir thoroughly, making sure that all crystals are dissolved. Let stand undisturbed for 5 min.

5.6 After the standing time, quickly fill a clean transmission cell with the solution and insert it into the cell holder. Again, be sure that no water or solution droplets are adhering to the outside of the cell. Read percent transmission to the nearest 1 %.

5.7 The standard 100 ppm solution is then made into a series of lower concentration solutions in accordance with the following dilution chart:

ml 100 ppm Sulfate	Solution ml H_2O	ppm Sulfate ion
90	10	90
80	20	80
70	30	70
60	40	60
50	50	50
40	60	40
30	70	30
20	80	20
10	90	10
0	100	0

5.8 Each solution is to be tested as described above and percent transmission recorded. The percent transmission is to be plotted against the ppm sulfate ion concentration and a smooth curve drawn through the points. The resulting chart is to be used in determining the sulfate concentrations of unknown samples of water or filtrate.

6. Procedure

6.1 The clay sample, if in crude lump form, is to be dried at 105°C for 24 h, crushed with the mortar and pestle and pulverized with a micro-pulverizer. If air-floated, continue with 6.2. If slurry continue with 6.4.

6.2 A 150-g portion of the ground dried clay is then weighed to the nearest 0.1 g.

6.3 Blunge the clay in 350 ml of reagent grade water for 30 min at high speed using the Hamilton Beach drink mixer.

6.4 Place a fresh piece of Baroid filter paper in the cylinder of a Baroid Filter Press. Pour the slurry into the cylinder and tighten the screw on the lid of the cylinder.

6.5 Pressure is applied gradually until 100 psi is obtained. Filtrate is caught in an Erlenmeyer flask. To eliminate errors from initial turbidity, the first 5 ml of filtrate is discarded.

6.6 Prepare the filtrate for testing by carefully transferring the desired quantity of filtrate from the Erlenmeyer flask to a clean 30 ml beaker using the appropriate pipette. A 25 ml total sample is used for testing; this sample may be comprised of between 1 ml and 25 ml of filtrate depending on the sulfate ion concentration in the filtrate. If the selected quantities yield readings beyond the calibration line, further dilution is required. For example, if one initially prepares a sample of 15 ml of filtrate and 10 ml of DI H_2O (25 ml total) and obtains a percent transmission reading below the calibration chart, then one should probably use 5 ml of filtrate and 20 ml of DI H_2O for the next test. One should use very accurate measuring pipettes when transferring any filtrate or water in this test.

6.7 Add 5 ml of glycerine solution and 2, 5 ml of salt-acid reagent to the solution in the 30 ml beaker.

6.8 Stir thoroughly with a clean glass rod.

6.9 Pour the solution into a transmission cell taking care not to create any air bubbles or spill solution on the side of the cell. (Do not touch the unfrosted side of the cell).

6.10 Adjust the meter to the 100 % transmission mark on the scale by using the calibration knob.

6.11 Pour the contents of the cell back into the beaker and thoroughly rinse and dry the cell. (Do not scratch the cell).

6.12 Add 1 THQ cupful of $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ crystals to the solution.

6.13 Stir carefully and make sure all the crystals are dissolved.

6.14 Allow to stand for five min.

6.15 Pour the solution into the transmission cell and insert the cell into the holder. Record the percent transmission.

7. Report

7.1 From the percent transmission readings obtained, use the following method to calculate soluble sulfate ion concentration in ppm.

7.2 Percent transmission is converted to ppm SO_4 of the dilute solution by using the prepared calibration chart.

7.3 The dilution factor is obtained by dividing 17.5 ml by the number of ml of filtrate used.

7.4 The water/solids factor is obtained by dividing the % water by the % solids. For 150-g clay and 350-g H_2O , the factor is 2.33.

7.5 Use the following formula to calculate concentration of soluble sulfate:

$$\text{ppm SO}_4 \text{ clay (dwb)} = (\text{ppm SO}_4 \text{ dilute solution} \times \text{dilution factor}) \quad (1)$$

× water/solids factor.

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org). Permission rights to photocopy the standard may also be secured from the ASTM website (www.astm.org/COPYRIGHT/).