



Designation: D857 – 07^{ε1}

Standard Test Method for Aluminum in Water¹

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^{ε1} NOTE—Added research report information to Section 14 editorially in November 2010.

1. Scope

1.1 This test method covers the direct flame atomic absorption determination of aluminum in the nitrous oxide-acetylene flame.

1.2 This test method is applicable to waters containing dissolved and total recoverable aluminum in the range from 0.5 to 5.0 mg/L. Aluminum concentrations as high as approximately 50 mg/L can be determined using this test method without dilution. However, no precision and bias data are available for concentrations greater than 5.0 mg/L.

1.3 This test method was tested on reagent, natural, and potable waters. It is the user's responsibility to ensure the validity of this test method for waters of untested matrices.

1.4 The same digestion procedure may be used to determine total recoverable nickel (Test Methods D1886), chromium (Test Methods D1687), cobalt (Test Methods D3558), copper (Test Methods D1688), iron (Test Methods D1068), lead (Test Method D3559), manganese (Test Method D858), and zinc (Test Methods D1691).

1.5 Precision and bias data have been obtained on reagent, natural, and potable waters. It is the responsibility of the user to ensure the validity of this test method on untested matrices.

1.6 *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.* For specific hazard statements, see [Note 1](#), [Note 2](#), and [Note 3](#).

1.7 Former Test Methods A (Fluorometric) and B and C (Spectrophotometric) were discontinued. Refer to [Appendix X1](#) for historical information.

¹ These test methods are under the jurisdiction of ASTM Committee D19 on Water and are the direct responsibility of Subcommittee D19.05 on Inorganic Constituents in Water.

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2. Referenced Documents

2.1 ASTM Standards:²

D858 Test Methods for Manganese in Water
D1066 Practice for Sampling Steam
D1068 Test Methods for Iron in Water
D1129 Terminology Relating to Water
D1193 Specification for Reagent Water
D1687 Test Methods for Chromium in Water
D1688 Test Methods for Copper in Water
D1691 Test Methods for Zinc in Water
D1886 Test Methods for Nickel in Water
D2777 Practice for Determination of Precision and Bias of Applicable Test Methods of Committee D19 on Water
D3370 Practices for Sampling Water from Closed Conduits
D3558 Test Methods for Cobalt in Water
D3559 Test Methods for Lead in Water
D4841 Practice for Estimation of Holding Time for Water Samples Containing Organic and Inorganic Constituents
D5810 Guide for Spiking into Aqueous Samples
D5847 Practice for Writing Quality Control Specifications for Standard Test Methods for Water Analysis

3. Terminology

3.1 *Definitions*— For definitions of terms used in these test methods, refer to Terminology D1129.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *total recoverable aluminum*—an arbitrary term relating to the forms of aluminum recovered in the acid digestion procedure specified in this test method.

4. Summary of Test Method

4.1 Aluminum is determined by direct atomic absorption with only the addition of an ionization suppressor and sensitivity enhancer (optional).

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. Significance and Use

5.1 Although there is little information available concerning the toxicological significance of aluminum in man, the American Water Works Association has established a water quality guideline or goal of a maximum of 0.05 mg/L. Under the National Pollution Discharge Elimination System (NPDES), some permits may set aluminum discharge limits. Some evidence does exist to indicate that low levels (5 mg/L) will interfere with activated sludge processes. For the above reasons monitoring of aluminum may be desirable.

5.2 Aluminum is monitored in boiler make-up water, where alum has been used, to determine whether aluminum is present after pretreatment. Residual aluminum may consume ion exchange capacity or consume boiler water treatment chemicals added to stoichiometrically chelate hardness ions (that is, calcium and magnesium) in boiler feed water.

5.3 Aluminum is monitored in cooling water make-up, since its presence may result in deactivation of anionic substances in scale or corrosion inhibitor treatment chemicals, or both. Deactivation may result in decreased performance of inhibitors.

6. Interferences

6.1 Aluminum ionizes slightly in the nitrous oxide-acetylene flame, but the addition of sodium chloride described in this test method suppresses this interference. By this technique, a maximum concentration of 9000 mg/L sodium, 9000 mg/L potassium, 4000 mg/L calcium, 4000 mg/L magnesium, 9000 mg/L sulfate, 9000 mg/L chloride, 9000 mg/L nitrate, and 9000 mg/L iron may be tolerated.

7. Apparatus

7.1 *Atomic Absorption Spectrophotometer*, for use at 309.3 nm.

7.2 *Aluminum Hollow-Cathode Lamp*—Multielement lamps are not recommended.

7.3 *Oxidant*—See 8.8.

7.4 *Fuel*—See 8.9.

7.5 *Pressure-Reducing Regulators*—The supplies of fuel and oxidant should be reduced by suitable regulators to the levels recommended by the manufacturer of the spectrophotometer.

NOTE 1—**Warning:** The nitrous oxide-acetylene flame is hazardous due to its flash-back potential. Follow the instrument manufacturer's recommended operating procedures closely.

8. Reagents and Materials

8.1 *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.³ 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.

8.2 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean reagent water conforming to Specification D1193, Type I. Other reagent water types may be used, provided it is first ascertained that the water is of sufficiently high purity to permit its use without lessening the bias and precision of the determination. Type II water was specified at the time of round-robin testing of this test method.

8.3 *Aluminum Solution, Standard (1 mL = 0.1 mg Al)*—Dissolve 1.758 g of aluminum potassium sulfate (AlK(SO₄)₂·12H₂O) in water. Add 1 mL of nitric acid and dilute to 1 L. A purchased stock solution of appropriate purity is also acceptable.

8.4 *Bis-(2-Ethoxyethyl) Ether*.

NOTE 2—**Warning:** Avoid inhalation. Perform all manipulation in a well-ventilated hood. This ether can form dangerous peroxides and should be inspected regularly for their presence.

8.5 *Hydrochloric Acid (sp gr 1.19)*—Concentrated hydrochloric acid (HCl).

8.6 *Nitric Acid (sp gr 1.42)*—Concentrated nitric acid (HNO₃).

8.7 *Sodium Chloride Solution (25.4 g/L)*—Dissolve 25.4 g of sodium chloride (NaCl) in water and dilute to 1 L.

8.8 *Oxidant:*

8.8.1 *Air*, which has been suitably dried and filtered, is used to support combustion before switching to nitrous oxide.

8.8.2 *Nitrous Oxide* is the required oxidant.

8.9 *Fuel:* Standard commercially available acetylene is the required fuel. The cylinder should be replaced at a gage pressure of 517 kPa (75 psi) to minimize the carry-over of acetone. Since “purified” grades contain a solvent that softens poly(vinyl chloride) tubing, its use constitutes a safety hazard and is not recommended.

9. Sampling

9.1 Collect samples in accordance with Practices D1066 or D3370, as applicable. For dissolved aluminum, filter the samples at the time of collection through a 0.45- μ m filter. Acidify the filtrate to pH 2 or less with nitric acid. For total recoverable aluminum, acidify the unfiltered sample to pH 2 or less at the time of collection. The holding time for samples may be calculated in accordance with Practice D4841.

9.2 Soak all glassware in hot HCl (1 + 1) for 2 h. Drain and rinse at least five times with water. Drain and flush with methyl alcohol, ethyl alcohol, or isopropyl alcohol.

³ *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 *Annual Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmacopeial Convention, Inc. (USPC), Rockville, MD.