Designation: E887 – 15

Standard Test Method for
Silica in Refuse-Derived Fuel (RDF) and RDF Ash[1]

This standard is issued under the fixed designation E887; 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 silica in refuse-derived fuel (RDF), RDF ash, fly ash, bottom ash, or slag.

1.2 The test method is an acid dehydration gravimetric procedure and is independent of interferences.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

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 determine the applicability of regulatory limitations prior to use.* For hazard statement, see Section 6.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1193 Specification for Reagent Water
E791 Test Method for Calculating Refuse-Derived Fuel Analysis Data from As-Determined to Different Bases
E829 Practice for Preparing Refuse-Derived Fuel (RDF) Laboratory Samples for Analysis (Withdrawn 2002)[3]

3. Summary of Test Method

3.1 Silicon compounds in RDF ash, fly ash, bottom ash, or slag are dissolved by alkali fusion and dehydrated with hydrochloric acid (HCl). Dehydration is completed by ignition, and the silica is volatilized as silicon tetrafluoride.

4. Apparatus

4.1 *Analytical Balance,* capable of weighing to 0.0001 g.

4.2 *Muffle Furnace*—The furnace shall have an operating temperature up to 1200°C.

4.3 *Hot Plate, Microwave Digester, or Steam Bath.*

4.4 *Platinum Crucibles,* 35 to 85-mL capacity.

4.5 *Graphite Crucibles,* 35 to 85-mL capacity.

4.6 *Fused Quartz Dishes,* 35 to 85-mL capacity.

5. Reagents and Materials

5.1 *Purity of Reagents*—Reagent grade chemicals shall be used in this test. 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.

5.2 *Purity of Water*—Unless otherwise indicated, reference to water shall be understood to mean at least Type III reagent water conforming to Specification D1193.

5.3 *Sodium Carbonate* (Na_2CO_3), anhydrous powder.

5.4 *Hydrochloric Acid* (HCl), concentrated, sp gr 1.19.

5.5 *Hydrochloric Acid* (1 + 3), Mix 1 volume of concentrated HCl with 3 volumes of water.

5.6 *Hydrochloric Acid* (1 + 1)—Mix 1 volume of concentrated HCl with 1 volume of water.

5.7 *Hydrochloric Acid* (1 + 99)—Mix 1 volume of concentrated HCl with 99 volumes of water.

5.8 *Sulfuric Acid* (1 + 1)—Mix 1 volume of concentrated sulfuric acid (H_2SO_4, sp gr 1.84) with 1 volume of water.

5.9 *Hydrofluric Acid* (HF), concentrated 48 to 51 %.

6. Hazards

6.1 Due to the origins of RDF in municipal waste, precautions should be observed when conducting tests on samples.

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[1] This test method is under the jurisdiction of ASTM Committee D34 on Waste Management and is the direct responsibility of Subcommittee D34.03 on Treatment, Recovery and Reuse.

Current edition approved Sept. 1, 2015. Published October 2015. Originally approved in 1982. Last previous edition approved in 2009 as E887 – 88 (2009). DOI: 10.1520/E0887-15.

[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.

[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. Pharmacopeial Convention, Inc. (USPC), Rockville, MD.

Recommended safety practices include use of suitable gloves when handling RDF; wearing dust masks (NIOSH-approved type), especially while milling RDF samples; conducting tests under negative pressure hoods when possible; and washing hands upon completion of activity and before eating or smoking.

7. Sampling

7.1 *Refuse-Derived Fuel (RDF):*

NOTE 1—ASTM Subcommittee E38.01 is currently in the process of developing procedures for sampling RDF.

7.1.1 RDF products are frequently nonhomogeneous. For this reason, significant care should be exercised to obtain a representative laboratory sample from the RDF lot to be characterized.

7.1.2 The sampling method for these procedures should be based on agreement between involved parties.

7.1.3 The laboratory sample must be air-dried and particle size reduced to pass a 0.5-mm screen for analysis. This procedure must be performed carefully to preserve the sample's representative characteristics (other than particle size) while preparing the analysis sample to be used in this procedure (see Practice E829).

7.2 *Refuse-Derived Fuel Ash, Fly Ash, Bottom Ash, or Slag*—The method of sampling for this procedure should be based on agreement between involved parties.

8. Sample Preparation

8.1 *Refuse-Derived Fuel:*

8.1.1 Weigh accurately 30 to 50 g of RDF analysis sample as prepared in 6.1 into a conditioned and preweighed fused quartz dish.

8.1.2 Spread out the analysis sample of RDF in a layer not over 38.1 mm (1½ in.) in depth.

8.1.3 Place the dish in the muffle at a low temperature (not greater than 100°C) and gradually heat to redness at such a rate as to avoid mechanical loss from too rapid expulsion of volatile matter.

8.1.4 Complete the conversion to ash at a temperature of 800 to 900°C (1470 to 1650°F).

8.1.5 Cool in a desiccator and stir the ash to ensure homogeneity of particle sizes. Be careful not to lose any ash from the dish during this stirring.

8.1.6 Spread the ash in a thin layer in the dish, and ignite in a stream of oxygen for 1½ h at 800 to 850°C (1470 to 1560°F) to ensure complete and uniform oxidation of the ash.

8.1.7 Cool the ash to room temperature in a desiccator.

8.1.8 Weigh the dish and the ash.

8.1.9 Calculate the percent ash as follows:

$$\%\ \text{Ash} = (C - A)/(B - A) \times 100 \quad (1)$$

where:

A = weight of fused quartz, g,
B = weight of fused quartz dish and sample, g, and
C = weight of fused quartz dish and ash, g.

8.2 *Refuse-Derived Fuel Ash, Fly Ash, Bottom Ash, or Slag:*

8.2.1 Prepare the RDF ash, fly ash, bottom ash, or slag by grinding the sample in an agate mortar to a particle size to pass a No. 200 (75-μm) sieve.

8.2.2 Weigh accurately 6 to 10 g of RDF ash, fly ash, bottom ash, or slag as prepared in 8.2.1 into a conditioned preweighed fused quartz dish.

8.2.3 Spread out the analysis sample of the ash to be analyzed in a layer not over 6.4 mm (¼ in.) in depth.

8.2.4 Place the dish in the muffle at a low temperature (not greater than 100°C), and gradually heat to redness at such a rate as to avoid mechanical loss from too rapid expulsion of volatile matter.

8.2.5 Complete the conversion to ash at a temperature of 800 to 900°C (1470 to 1659°F).

8.2.6 Cool in a desiccator and stir the ash to ensure homogeneity of particle sizes. Be careful not to lose any ash from the dish during this stirring.

8.2.7 Spread the ash in a thin layer in the dish and ignite in a stream of oxygen for 1½ h at 800 to 850°C (1470 to 1560°F) to ensure complete and uniform oxidation of the ash.

8.2.8 Cool the ash to room temperature in a desiccator.

8.2.9 Weigh the dish and the ash.

8.2.10 Calculate the percent residue after ignition as follows:

$$\%\ \text{Residue after ignition} = (F - D)/(E - D) \times 100 \quad (2)$$

where:

D = weight of fused quartz dish, g,
E = weight of fused quartz dish and sample, of RDF ash, fly ash, bottom ash or slag, g, and
F = weight of fused quartz dish and residue after ignition of RDF ash, fly ash, bottom ash, or slag, g.

9. Procedure

9.1 *Sample Fusion:*

9.1.1 Weigh 0.010 to 0.100 g of the prepared RDF ash as prepared in 8.1 or the residue of RDF ash, fly ash, bottom ash, or slag as prepared in 8.2 into a platinum or graphite crucible.

9.1.2 Add 1.0 g of Na_2CO_3. Mix the ash and Na_2CO_3 well, then add an additional 0.5 g of Na_2CO_3 to cover the mixture.

9.1.3 Place the crucible into a clean silica or refractory tray, and place in a muffle furnace preheated to 1000°C and maintain until the mass is quiescent (about 45 min).

9.1.4 Set the crucible aside to cool.

9.1.5 Rinse off the outside of the crucible, and place it on its side in a 300-mL casserole or beaker about one-third full of water. Warm and stir until the cake disintegrates and can be easily removed.

9.1.6 By means of platinum tipped tongs, lift the crucible out of the liquid, rinsing it thoroughly with water followed by rinsing with dilute hydrochloric acid (HCl, 1 + 3); adding the rinse to the casserole or beaker.

9.2 *Acid Dehydration:*

9.2.1 Very slowly and cautiously add 20 mL of concentrated hydrochloric acid (HCl, sp gr 1.19) to the covered casserole or beaker (see Note 2). Remove the cover and rinse. If any gritty particles are present, the fusion is incomplete and must be repeated, using a new sample and a larger amount of Na_2CO_3.