Designation: E829 – 16

Standard Practice for Preparing Refuse-Derived Fuel (RDF) Laboratory Samples for Analysis[1]

This standard is issued under the fixed designation E829; 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 practice covers the preparation of RDF laboratory samples for analysis, the laboratory samples having been previously obtained from representative RDF samples.

1.2 The determination of the air-dry loss of the RDF is part of this preparation procedure and must be performed prior to the particle size reduction.

1.3 The practice given may also be used for other RDF types but additional sample preparation steps may be necessary prior to the application of this method.

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. Specific hazard statements are given in Section 7.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D5681 Terminology for Waste and Waste Management

D6044 Guide for Representative Sampling for Management of Waste and Contaminated Media

E180 Practice for Determining the Precision of ASTM Methods for Analysis and Testing of Industrial and Specialty Chemicals (Withdrawn 2009)[3]

E790 Test Method for Residual Moisture in Refuse-Derived Fuel Analysis Samples

E791 Test Method for Calculating Refuse-Derived Fuel Analysis Data from As-Determined to Different Bases

3. Terminology

3.1 *Definitions*—For definitions of terms common to waste and waste management used in this practice, refer to Terminology D5681 and ASTM STP 832.[4]

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *air-drying*—a process of partially drying RDF to bring its moisture content to near equilibrium with the ambient atmosphere in which further reduction, division, and characterization of the sample are to take place. In order to bring about this equilibrium, the RDF is usually subjected to drying under controlled temperature conditions ranging from 30 to 40°C.

3.2.2 *analysis sample*—final subsample prepared from the air-dried laboratory sample but reduced by passing through a mill with a 0.5-mm (0.02-in.) size or smaller final screen.

3.2.3 *bias*—a constant or systematic error in the test results. The error is a persistent positive or negative deviation from the accepted reference value.

3.2.4 *gross sample*—a sample representing one lot and composed of a number of increments on which neither reduction nor division has been performed.

3.2.5 *laboratory sample*—a representative portion of the gross sample received by the laboratory for further analysis.

3.2.6 *lot*—a large designated quantity (greater than the quantity of the final sample) of RDF that can be represented by a properly selected gross sample.

3.2.7 *precision*—a term used to indicate the capability of a person, an instrument, or a method to obtain reproducible results; specifically, a measure of the random error as expressed by the variance, the standard error, or a multiple of the standard error.

3.2.8 *refuse-derived fuel*—solid forms of refuse-derived fuels from which appropriate analytical samples may be prepared defined as follows in ASTM STP 832:[4]

RDF–1—Waste used as a fuel in as-discarded form with only bulky wastes removed..

RDF–2—Waste processed to coarse particle size with or

[1] This practice 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.

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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.

[4] Hollander, H.I. *Thesaurus on resource recovery terminology.* Philadelphia: American Society for Testing and Materials, 1983

without ferrous metal separation.

RDF–3—combustible waste fraction processed to particle sizes, 95 % weight passing 2-in. screening.

RDF–4—Combustible waste processed into powder form, 95 weight % passing 10-mesh screening.

RDF–5—Combustible waste densified (compressed) into the form of pellets, slugs, cubettes, or briquettes.

3.2.9 *representative sample*—a sample collected in such a manner that it has characteristics equivalent to the lot sample.

3.2.10 *sample division*—the process of extracting a smaller sample from a sample so that the representative properties of the larger sample are retained. During this process it is assumed that no change in particle size or other characteristics occurs.

3.2.11 *sample preparation*—the process that includes drying, size reduction, division, and mixing of a laboratory sample for the purpose of obtaining an unbiased analysis sample.

3.2.12 *sample reduction*—the process whereby sample particle size is reduced without change in sample weight.

3.2.13 *significant loss*—any loss that introduces a bias in final results that is of appreciable importance to concerned parties.

4. Summary of Practice

4.1 Sample moisture is reduced by air-drying to allow the mechanical reduction of the sample without significant change to the sample's fuel properties. The final sample is in a form suitable for further analysis.

5. Significance and Use

5.1 Using this procedure a sample of RDF can be converted into a physical form suitable for laboratory fuel analysis.

5.2 As indicated in Test Method E791, air-dry moisture, which is determined by this procedure, is essential to the calculation of other laboratory results on an as-received basis. The air-dry moisture value is used in conjunction with the results of the residual moisture determination in Test Method E790 to calculate total sample moisture.

6. Apparatus

6.1 *Air-Drying:*

6.1.1 *Drying Oven*—A large chamber mechanical draft oven capable of maintaining a controlled temperature in the range from 25 to 40 ± 1°C. Air changes should be at the rate of one to four changes per minute. Air flow should be baffled to prevent samples from being blown out of the sample containers.

6.1.2 *Drying Pan*—A noncorroding pan or mesh basket to be used for holding the sample during air-drying operations.

6.1.3 *Balance (Laboratory Sample)*—A balance of sufficient capacity to weigh the sample and container with a sensitivity of 0.1 g.

6.2 *Sample Reduction:*

6.2.1 *Mill*—A mill operating on the principle of cutting or shearing action shall be used for sample particle size reduction. It shall have the capability to regulate the particle size of the final product by means of either interchangeable screens or mill adjustments. The mill shall be enclosed and should generate a minimum amount of heat during the milling process to minimize the potential for loss of moisture. The final product shall pass through a 0.5-mm or smaller screen into a receiver integral with the mill. Access should be provided so that the mill can be quickly and easily cleaned between samples.

6.3 *Analysis Sample Containers*—Heavy, vapor impervious bags, properly sealed; or noncorroding cans, glass jars, or plastic bottles with airtight sealing covers may be used to store RDF samples for analysis. Containers shall be checked for suitability by measuring weight loss or gain of the sample and container stored for 1 week under ambient laboratory conditions. The weight loss or gain should be less than 0.5 % of the sample weight stored in the container.

6.4 *Drying Oven*—A drying oven of either the mechanical or natural circulation type which is capable of constant uniform temperature within the specimen chamber regulated at 107 ± 3°C.

6.5 *Shredder*—A laboratory shredder capable of shredding or cutting larger particle sizes of solid waste. The final product shall pass through a 2-in. or smaller screen into a receiver integral with the shredder.

NOTE 1—A garden-type shrubbery shredder equipped with a screen and bag for collection of shredded samples is satisfactory.

7. Hazards

7.1 Due to the origins of RDF in municipal waste, precautions should be observed when conducting tests on samples. Recommended practices include use of gloves when handling RDF; wearing dust masks (NIOSH-approved), especially while shredding RDF samples; conducting tests under a negative pressure hood when possible; and washing hands before eating, using the restroom, or smoking.

7.2 Laboratory sample handling and reduction shall be performed by trained personnel. If all precautions regarding sample preparations are not followed, the error in the preparation may bias some or all of the analyses performed on the sample.

7.2.1 All preparative steps shall be done rapidly and in as few operations as possible, since moisture loss depends on several factors other than total moisture content, such as time required for milling, atmospheric temperature and humidity, and the type of laboratory sample reduction equipment.

7.2.2 At all times RDF samples should be protected from moisture change due to exposure to rain, snow, and sun, or contact with absorbent materials.

7.2.3 Samples should be transported to the laboratory and analyzed as soon as possible. If any sample-handling step involved an extended time period, the sample and container should be weighed before and after the process to determine any weight gain or loss. This weight gain or loss shall be included in the calculation of moisture content.

7.2.4 Force-feeding of the sample through the mill can overload the motor. An overload can cause rapid heating of the rotor and mill chamber with possible loss of residual moisture.

8. Sampling

NOTE 2—See Guide D6044

8.1 RDF products are frequently inhomogeneous. For this reason significant care should be exercised to obtain a representative sample from the RDF lot to be characterized.

8.2 The sampling method for this procedure should be based on agreement between involved parties.

8.3 For this procedure the laboratory sample size will normally not exceed 2 kg with some variation possible depending on laboratory equipment availability and sample size requirements.

8.3.1 Due to the heterogeneous nature of RDF, dividing a laboratory sample to a very small size analyses sample may result in unrepresentative results. Since milling operations mix the sample as well as reduce particle size, laboratory samples should not be divided before the initial preparation steps have been completed.

9. Procedure

9.1 Weigh the entire laboratory sample into a tared drying pan. Sample depth in the drying pan shall be no greater than 100 mm (4 in.) and any lumps of sample should be broken up. Use more than one pan if necessary. If a very fine mesh-type drying pan is used, size the mesh such that the sample will not be lost.

9.2 Air-dry the sample at 10 to 15°C above ambient temperature, but not greater than 40°C above ambient temperature until the weight loss is less than 0.1 % of the sample weight per hour. Samples can normally be allowed to air-dry for a set time period such as overnight or 24 h. To speed the drying stage the sample may be carefully stirred avoiding loss of sample.

NOTE 3—The air discharge of the forced draft air-drying oven should be filtered prior to discharge to minimize laboratory contamination by air-entrained RDF dust.

9.3 Separate and weigh the sample millables and nonmillables for classification and use, or analysis, if necessary. Calculate the millables and nonmillables as described in 10.2.

9.4 Dry a representative portion of the air-dried millable fraction at 107 ± 3°C to constant weight as follows:

9.4.1 Heat a clean, empty drying pan at a minimum temperature of 107 ± 3°C for at least 1 h. Cool to ambient temperature, and transfer the millable fraction to a desiccator and tare weigh to an accuracy of 0.5 g.

9.4.2 Place the laboratory sample of RDF in the drying pan(s). A maximum sample depth of 50 to 100 mm is recommended. Weigh the pan and sample to an accuracy of 0.5 g. More than one drying pan may be necessary.

NOTE 4—If a mesh-type pan is used, place a clean sheet of aluminum foil under the pan to check for any sample fall through. If any occurs, a smaller-mesh drying pan is required.

9.4.3 Place the pan and sample in a drying oven at 107 ± 3°C for a minimum of 1 h.

NOTE 5—Observe the sample periodically to make certain that the sample does not decompose or ignite at this temperature.

9.4.4 After an appropriate drying time, remove the pan and sample from the oven and place in a desiccator to cool. When cool, weigh the sample and pan to the nearest 0.5 g.

9.4.5 Place the sample and pan in the oven for an additional 1 h at 107 ± 3°C.

9.4.6 Remove the sample and pan and place in the desiccator to cool to ambient temperature. When cool, weigh the sample and pan to the nearest 0.5 g. If the sample weight loss was less than 0.1 %/h of the original sample weight, the determination is complete; if not, repeat 9.4.5 and 9.4.6.

NOTE 6—At this point the dried sample can be used for further analysis if desired.

9.4.7 Calculate the moisture of the nonmilled millable fraction of the laboratory sample as described in 10.3.

9.5 Reduce the air-dried sample to a smaller particle size by using a cutting- or shearing-type shredder or mill. The final product should pass through a 0.5-mm or smaller screen. Depending on the specific RDF product, this step may involve more than one stage or reduction, that is, passing the sample through a shredder or mill with larger size screens first and then milling to pass the final screen. Even though the sample has been air dried, minimum atmospheric exposure is recommended and the milling process should be conducted such as to avoid significant moisture change. If necessary, the milled sample should be well mixed by either manual or mechanical means to ensure thorough mixing of heavy fine particles and milled "fluff".

9.6 The mixed, air-dried, finely ground laboratory sample can then be further subdivided to an analysis-size sample (see Note 7). Retain a minimum of 50 g as the analysis sample. Any division method used shall ensure that the retained analysis sample is representative of the original laboratory sample.

NOTE 7—If it is possible to riffle the product, a small laboratory riffle can be used to divide the sample. If it is not possible to riffle the sample, use some other valid method to divide the sample.

9.7 Keep the analysis sample in a labeled sample container having a moisture-tight seal.

9.8 Determine the residual moisture of the analysis sample as described in Test Method E790.

10. Calculation

10.1 Calculate the air-dry moisture as follows:

$$ADL = [(G - L)/G] \times 100 \quad (1)$$

where:

ADL = air-dry loss, %,
G = weight of the laboratory sample before air-drying, and
L = weight of the laboratory sample after air-drying.

10.2 Calculate the millables and the nonmillables of the air-dried sample as follows:

$$M = [W_M/(W_M + W_{NM})] \times 100 \quad (2)$$

where:

M = millables, %,
W_M = weight of the millables in the air-dried sample,

NM = nonmillables, %, and
W_{NM} = weight of the nonmillables in the air-dried sample.

10.3 Calculate the moisture in the nonmilled millable fraction of the air-dried fraction of the laboratory sample as follows:

$$MAD = [(W_{bd} - W_{ad})/W_{bd}] \times 100 \quad (3)$$

where:

MAD = moisture of nonmilled millable fraction of the air-dried sample, %,
W_{bd} = weight of the nonmilled millable fraction of the air-dried sample before drying at 107 ± 3°C, and
W_{ad} = weight of the nonmilled millable fraction of the air-dried sample after drying at 107 ± 3°C.

NOTE 8—Moisture loss or gain during particle-size reduction (shredding/milling) can be determined by comparing the moisture of the nonmilled millable fraction of the air-dried sample with the residual moisture-content value and used accordingly.

NOTE 9—Nonmillables usually are noncombustible and can be used in contributing to the ash value or noncombustible-value portion of the sample.

11. Precision and Bias

11.1 The standard deviations of the individual determinations, in percent absolute, are:

Typical Average Value	Within Laboratory	Between Laboratories
16	1.8	2.9

11.1.1 These precision estimates are based on an interlaboratory study conducted in accordance with Practice E180.

11.2 *Bias*—Due to the variability in what is considered to be in equilibrium with ambient conditions, it is not possible to describe any measure of bias regarding this practice.

12. Keywords

12.1 refuse-derived fuel (RDF)