Designation: E 790 – 87 (Reapproved 2004)

Standard Test Method for Residual Moisture in a Refuse-Derived Fuel Analysis Sample[1]

This standard is issued under the fixed designation E 790; 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 residual moisture in an analysis sample of RDF. It is used to calculate to the dry basis other determinations performed on the analysis sample. It is used with the air-dry moisture results to calculate total moisture (Note 1). The total moisture is used to calculate as-received values or other analyses performed on the sample.

NOTE 1—In some instances RDF moisture may change during the size-reduction steps of the analysis sample preparation procedure. This moisture change, unless suitable corrections are made, will affect the accuracy of the total moisture value as calculated from the air-dry and residual moisture results.

1.2 The values stated in acceptable metric units are to be regarded as standard. The values given in parentheses are for information only.

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.* For more specific precautionary information see Section 7.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 3173 Test Method for Moisture in the Analysis Sample of Coal and Coke

E 180 Practice for Developing Precision of ASTM Methods for Analysis and Testing of Industrial Chemicals

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

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

3.1.2 *analysis sample*—the 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.

3.1.3 *bias*—a systematic error that is consistently negative or consistently positive. The mean of errors resulting from a series of observations that does not tend towards zero.

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

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

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

3.1.7 *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.

3.1.8 *refuse-derived fuels*—solid forms of refuse-derived fuels from which appropriate analytical samples may be prepared are defined as follows in *ASTM STP 832*.[3]

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

RDF-2—Wastes processed to coarse particle size with or without ferrous metal separation.

RDF-3—Combustible waste fraction processed to particle sizes, 95 % passing 2-in. square screening.

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

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

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

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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 D34.06 on 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] *Thesaurus on Resource Recovery Terminology, ASTM STP 832*, ASTM, 1983, p. 72.

3.1.10 *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.

3.1.11 *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.

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

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

4. Summary of Test Method

4.1 This test method is based on the loss in weight of an air-dried analysis sample of RDF under rigidly controlled conditions of temperature, time, and air flow.

4.2 The total moisture is calculated from the loss or gain in air drying and the residual moisture as determined by this test method.

5. Significance and Use

5.1 The treatment of the sample as specified herein is intended for the purpose of determining the residual moisture present in an analysis sample of RDF.

5.2 The residual moisture value is used to convert as-determined analyses such as gross heating value, sulfur, and ash to a dry sample basis.

6. Apparatus

6.1 *Drying Oven*:

6.1.1 *Referee Type*—The oven shall be so constructed as to have a uniform temperature within the specimen chamber, have a minimum excess air volume, and be capable of constant temperature regulation at 107 ± 3°C. Provision shall be made for renewing the preheated air in the oven at the rate of two to four times a minute, with the intake air dried by passing it through a desiccant. An oven similar to the one illustrated in Fig. 1 of Test Method D 3173 is suitable.

6.1.2 *Routine Type*—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.

NOTE 2—Either type of oven may be used for routine determinations. However, the referee-type oven shall be used to resolve differences between determinations.

6.2 *Containers*—A convenient form that allows the ash determination to be made on the same sample is a porcelain capsule 22 mm in depth and 44 mm in diameter or a fused silica capsule of similar shape. This shall be used with a well-fitting flat aluminum cover. Platinum crucibles or glass capsules with ground-glass caps may also be used. They should be as shallow as possible consistent with convenient handleability.

6.3 *Analytical Balance*, with 0.1 mg sensitivity.

6.4 *Analysis Sample Containers*—Heavy (minimum 4 mil), vapor-impervious bags, properly sealed; or noncorroding cans, glass jars, or plastic bottles with air-tight sealing covers 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.

7. Precautions

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

7.2 Laboratory sample handling shall be performed by trained personnel. All operations shall be done rapidly as possible to avoid sample moisture changes due to atmospheric exposure.

7.3 Since heavy fine particles tend to segregate rapidly in the RDF analysis sample, the analyst should exercise care to assure that the analysis sample is well-mixed prior to performing this determination.

7.4 When the residual moisture is to be used for the determination of total moisture, special care shall be taken to avoid any change in sample moisture between the completion of air drying and analysis for residual moisture. It is recommended that the delay between sample preparation and the determination of residual moisture be a maximum of 72 h.

8. Sampling [4]

8.1 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.

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

8.3 The laboratory sample must be air-dried and particle size reduced to pass a 0.5-mm screen for this 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.

9. Procedure

9.1 Heat the empty containers and covers under the conditions at which the sample is to be dried, place the stopper or cover on the container, cool over a desiccant for about 15 to 20 min, and weigh. Mix the sample, if necessary, and dip out with a spoon or spatula from the sample bottle approximately 1 g of the sample. Put the sample quickly into the container, cover, and weigh at once.

NOTE 3—If weighing bottles with air-tight covers are used, it may not

[4] ASTM Subcommittee E38.01 is currently in the process of developing procedures for sampling RDF and the preparation of an analysis sample. The chairman of E38.01 should be contacted for details.

be necessary to preheat the moisture analysis container nor to desiccate it after drying.

9.2 Remove the cover and place in a desiccator. Quickly place the uncovered container into an oven preheated to 107 ± 3°C through which is passed a current of dry air. Close the oven at once and heat for 1 hr. Open the oven, remove, cover the container quickly, and cool in a desiccator over desiccant. Weigh the sample and container as soon as cooled to room temperature.

10. Calculation (see Note 1)

10.1 Calculate the percent residual moisture, *R*, in the analysis sample as follows:

$$R = \frac{S - B}{S} \times 100 \quad (1)$$

where:
S = grams of analysis sample used, and
B = grams of sample after heating.

10.2 Calculate the percent total moisture in the laboratory sample, as follows:

$$M = \frac{R\,(100 - A)}{100} + A \quad (2)$$

where:
R = residual moisture, %, and
A = air dry loss determined during preparation of the analysis sample, %.

10.3 To convert other parameters determined on the analysis sample, such as ash, sulfur, and gross calorific value, to a dry sample basis, the following equation can be used:

$$P_{dry} = \frac{P_{ad}\,(100)}{100 - R} \quad (3)$$

where:
P_{ad} = parameter, %“ as-determined” on the analysis sample,
R = residual moisture, % (see 10.1), and
P_{dry} = parameter, % expressed on a dry sample basis.

11. Precision and Bias

11.1 *Precision*:

11.1.1 The standard deviations of individual determinations, in percent absolute are as follows:

Typical Average Value	Within Laboratories	Between Laboratories
2.5–4.5 %	0.15 %	0.50 %

11.1.2 The above precision estimates are based on an interlaboratory study conducted in accordance with Practice E 180.

11.2 *Bias*—The bias of this test method has not been determined due to a lack of a recognized standard reference material.