Designation: E 828 – 81 (Reapproved 2004)

Standard Test Method for Designating the Size of RDF-3 From its Sieve Analysis[1]

This standard is issued under the fixed designation E 828; 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 of designating the size of refuse-derived fuel from its sieve analysis is applicable to the classified light fraction (RDF-3) of shredded municipal or industrial waste materials less than 0.15 m (6 in.) in size.

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 2234 Test Method for Collection of a Gross Sample of Coal

E 11 Specification for Wire-Cloth Sieves for Testing Purposes

E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

3. Terminology

3.1 *Definitions:*

3.1.1 *air drying*—a process of partial drying of RDF-3 to bring its moisture content near to equilibrium with the atmosphere in the room in which the sieving is to take place.

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

3.1.3 *laboratory sample*—a representative portion of the gross sample delivered to the laboratory for further analysis.

3.1.4 *lot*—a large designated quantity of RDF-3.

3.1.5 *representative sample*—a sample collected in such a manner that it has characteristics equivalent to the material being sampled.

3.1.6 *sample division*—the process of extracting a smaller sample from a gross sample wherein the representative properties of the large sample are retained.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *refuse-derived fuel (RDF-3)*—a shredded fuel derived from municipal solid waste (MSW) that has been processed to remove metal, glass, and other inorganics. This material has a particle size such that 95 weight % passes through a 2-in. square-mesh screen.

NOTE 1—Other refuse-derived fuel may be classified as follows:

RDF-1—Wastes used as a fuel in as-discarded form.
RDF-2—Wastes processed to coarse particle size with or without ferrous metal separation.
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.
RDF-6—Combustible waste processed into liquid fuel.
RDF-7—Combustible waste processed into gaseous fuel.

4. Summary of Test Method

4.1 This test method covers the separation of an RDF sample into defined size fractions and expressing those fractions as a weight percent of an air-dried sample.

5. Significance and Use

5.1 The purpose of this test method is to provide a means of designating the size classification of RDF-3 for use by consumers and producers of RDF-3.

6. Apparatus

6.1 *Sieves*:

6.1.1 Use sieves conforming to Specification E 11. For recommended sizes see Table 1.

6.1.1.1 For RDF-3 and larger than 50 mm (2 in.) screens having rectangular frames 0.6 to 0.7 m^2 (6 to 8 ft^2) sieve area are satisfactory.

6.1.1.2 For RDF-3 50 mm (2 in.) or smaller, rectangular frames having 2 to 4 ft^2 (0.2 to 0.4 m^2) sieve area are satisfactory.

[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.
Current edition approved July 31, 1981. Published February 1982.

[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.

TABLE 1 Recommended Sieve Sizes (ASTM E11 – 70)

For screening RDF-3 the following screen series is recommended:	
Standard (mm)	Alternative (in. or mesh)
100 mm	4 in.
50 mm	2 in.
25 mm	1 in.
12.5 mm	½ in.
6.3 mm	¼ in.
3.35 mm	No. 6
1.70 mm	No. 12
850 µm	No. 20
425 µm	No. 40
The following intermediate screen sizes may be used as needed:	
Standard (mm)	Alternative (in. or mesh)
75 mm	3 in.
37.5 mm	1.5 in.
19.0 mm	¾ in.
9.5 mm	⅜ in.
4.75 mm	No. 4
2.36 mm	No. 8
1.18 mm	No. 16
600µ m	No. 30

6.1.1.3 For RDF-3 smaller than 0.01 m (0.5 in.), circular sieves 0.3 m (12 in.) or 0.2 m (8 in.) in diameter are satisfactory.

6.2 *Sieving Devices*:

6.2.1 Hand sieving is permissible.

6.2.2 Sieving machines that provide the necessary agitation and tumbling action may be used. See Annex A1 for recommended screen sizes and machines.

6.3 *Balance* (laboratory sample), having sufficient capacity to weigh the sample and container with a sensitivity of 0.5 g in 1000 g.

7. Precautions

7.1 Due to the origins of RDF-3 in municipal waste, common sense dictates that some precautions be observed when conducting tests on the samples. Recommended hygienic practices include use of gloves when handling RDF-3; wearing masks (NIOSH-approved type), especially while shredding RDF-3 samples; conducting tests under a negative pressure hood when possible; and washing hands before eating or smoking.

8. Sampling

8.1 Collect increments regularly and systematically so that the entire quantity of RDF sampled will be representative proportionately in the gross sample, and with such frequency that a gross sample of the required amount shall be collected. No sampling procedure shall be used that alters the particle size distribution.

8.2 Establish the sampling procedures to be used, the number and size of samples required to obtain a representative sample, and the method of division of the gross sample into the laboratory sample in accordance with an agreement between purchaser and supplier.

NOTE 2—The statistical methods described in Test Method D 2234 may be applicable in determining the number and size of samples.

8.3 Division of the gross sample into the laboratory sample may be done by coning and quartering, riffling, or by other appropriate method.

8.4 The sample shall be approximately 2 kg (4.4 lb) in weight.

8.5 Air-dry the sample in a ventilated drying oven to constant weight at 10 to 15°C above the ambient temperature. (Calculate the loss in weight to percentage of moisture that shall constitute the air-dry loss in the sieve analysis sample.)

9. Procedure

9.1 Weigh the air-dried sample.

9.2 *Hand Sieving*:

9.2.1 Starting with the sieve having the largest opening, sieve a portion of the RDF-3 in such an increment as will allow the individual pieces to be in direct contact with the meshes of the screen after the completion of shaking of each increment. In shaking, apply a vertical as well as horizontal motion in order to allow all small particles to pass through the openings, until no more material will pass. Hand fitting is not permitted.

9.2.2 Pass the material through successively smaller sieves in increments small enough to avoid matting of the material to the extent that the undersized material cannot reach and pass the screen.

9.2.3 Continue to shake the sieve after each increment is added until no significant amount of material passes through the screen.

9.3 *Machine Sieving*:

9.3.1 When sieving machines are used, test their thoroughness of sieving by comparison with hand methods as described in 9.2.

9.3.2 Stack the sieves progressively starting with the smallest aperture size, above the pan, to the largest aperture size at the top.

9.3.3 Introduce the air-dried sample above the largest screen in small enough increments such that matting of the material does not occur to an extent that prevents the undersize material from reaching and passing the screen. The amount of RDF-3 added to the top screen in any increment must not exceed one third of the volume of the screen, in order to prevent matting or blinding.

9.3.4 After adding each increment, assemble the pans or trays in the machine and turn on agitation for 10 min, or up to 15 min if necessary, to complete screening.

9.3.5 Inspect each screen for evidence of matting. If a screen is mostly or entirely covered with a mat, decrease the size of the initial increments such that no mat forms on any sieve, and repeat the tests.

9.3.6 When sieving of each increment is complete, promptly determine the weight of material remaining on each screen to the nearest 0.5 g. If more than one increment is sieved to pass the entire sample, add the incremental weights remaining on each sieve. If the sum of the weights show a loss of 2 % or more, reject the analysis and make another test using a second sample.

NOTE 3—In order to obtain a complete characterization of the size range of an RDF-3 sample, it is necessary that the number of sieves be such that no more than 25 % of the gross sample weight will be retained on any given sieve. The recommended screen series are listed in Table 1.

NOTE 4—The sand and glass contained in a sample of RDF-3 has a strong tendency to segregate from the light fraction. For this reason great care must be taken to include the entire sample in the sieve analysis. When a sample is divided, the sand will probably not divide equally into the sample portions. Samples may be divided for convenience in feeding the sieving apparatus, but the weights of all portions of the sample must be properly summed so that the entire sample has been included in the sieve analysis.

NOTE 5—Some abrasion and physical degradation of the sample by the screen can occur during the sieving operation. The analyst shall monitor and report his observations of any sample degradation.

10. Report

10.1 Report the weights of the size fractions as a percentage of the weight of the air-dried laboratory sample of RDF-3. Calculate to the nearest 0.5 % the percentages of the size fractions remaining on each sieve, and the percentage passing through the smallest aperture sieve. See sample report form in Fig. 1.

10.2 Record the results starting with the largest aperture size. If desirable, the percentage can also be reported on a cumulative basis, as cumulative percentage greater than size or cumulative percentage less than size where size refers to sieve aperture size or mesh number.

REPORT OF SIEVE ANALYSIS OF RDF-3

All weights in grams

Sample Identification no. _____

Date sampled: _____

Sample rec'd. _____

Source: _____

_____

AIR DRY LOSS

Weight Before _____

Weight After _____

Weight Loss _____

% A-D Loss _____

Sieve No. (mm)	Alternative (in. mesh)	Weight retained	% retained	% cumulative greater than size
100 mm	4 in.			
50 mm	2 in.			
25 mm	1 in.			
12.5 mm	½ in.			
6.3 mm	¼ in.			
3.35 mm	No. 6			
1.70 mm	No. 12			
850 μm	No. 20			
425 μm	No. 40			
In pan through 425 μm	No. 40			
(Total)				

NOTE 1—Calculate percentages to the nearest 0.5 %.
NOTE 2—If the sum of the weights shows a loss of over 2 %, reject the analysis and make another test.
NOTE 3—Nominal top size sieve shall retain 1 % to 5 % of A-D sample weight. The nominal bottom size sieve shall allow no more than 15 % of A-D sample to pass.

Analyst: _____

Date: _____

FIG. 1 Sample Report Form

10.3 The sieve aperture defining the upper particle size limit shall be that sieve of the series with the smallest aperture size that will retain less than 5 % of the sample weight. This sieve size is the nominal top particle size (see Annex A2 for definition).

10.4 The sieve aperture size defining the lower particle size limit shall be the smallest aperture sieve of the series which passes less than 15 % of the sample weight. This sieve size is the nominal bottom particle size (see Annex A2 for definition).

10.5 The term defining particle sizes shall be written with the nominal top size first, followed by the nominal bottom size.

10.6 International Standard sieve sizes shall be expressed as millimetre (mm), or micrometre, (μm), representing the actual size of the sieve opening. U.S. Standard sieve sizes shall be expressed as inches (in.) or by mesh numbers representing the number of mesh wires per inch. For sieves No. 4 and smaller sieve sizes, the abbreviation No., shall be used each time a sieve is indicated by a mesh number.

11. Precision and Bias

11.1 The precision and bias of this test method are yet to be determined.

ANNEXES

(Mandatory Information)

A1. SIEVING DEVICES

A1.1 Horizontal Rotating Cylindrical Screens

A1.1.1 Horizontal rotating cylindrical screens are preferable for screening flat materials such as RDF-3, because they readily provide the lifting and tumbling action required to bring all materials to the screen surface. However, no screens of this sort are commercially available at this time.

A1.2 Rectangular Testing Screen[3] (Fig. A1.1)

A1.2.1 Trays have 0.46 by 0.66-m (18 by 26-in.) clear screen area, designed primarily for the 0.1 m (4 in.) to No. 4 mesh size, but will handle small amounts of finer material down to No. 200 mesh. The screens handle samples up to a maximum of 1 ft^3(0.03 m^3). Screening motion is essentially a vertical variation, which is factory set for the type of material to be tested. Up to six screen trays can be held in the vibrating unit.

[3] Gilson testing screen model TS-1, having six screens and a pan 0.46 by 0.66 m (18 by 26 in.), has been found to be satisfactory for RDF-3 under 0.05 mm (2 in.), when equipped with a special low-amplitude drive shaft. Available from Gilson Screen Co., P.O. Box 99-T, Malinta, OH 43535.

A1.3 Rotary Pan Sieve[4] (Fig. A1.2)

A1.3.1 This device can be operated with up to nine full height 200 mm (8-in.) or 300 mm (12-in.) sieving screens and a pan, assembled together in a set, and held at an angle of 45° while rapping and rotating the assembly. A timer is provided to stop the mechanical action after time intervals up to 15 min.

A1.4 Testing Sieve Shaker[5]

A1.4.1 This device reproduces the circular and tapping motion given testing sieves in hand-sieving, and can hold a series of size full-height, 200-mm (8-in.) sieves in one operation of the machine.

[4] Rainhart Rotary Pan Sieve using 300-mm (12-in.) or 200-mm (8-in.) circular sieves has been found to be satisfactory for RDF-3 under 12.5 mm (0.5 in.). Available from Rainhart Co. (Testing Equipment), 604-T Williams, Austin, TX 78752.

[5] A Rotap screening machine with 200-mm (8-in.) circular sieve has been found to be satisfactory for RDF-3 under 12.5 mm (0.5 in.). Available from W. S. Tyler Co., Inc., 8200 Tyler Blvd., Mentor, OH 44060.

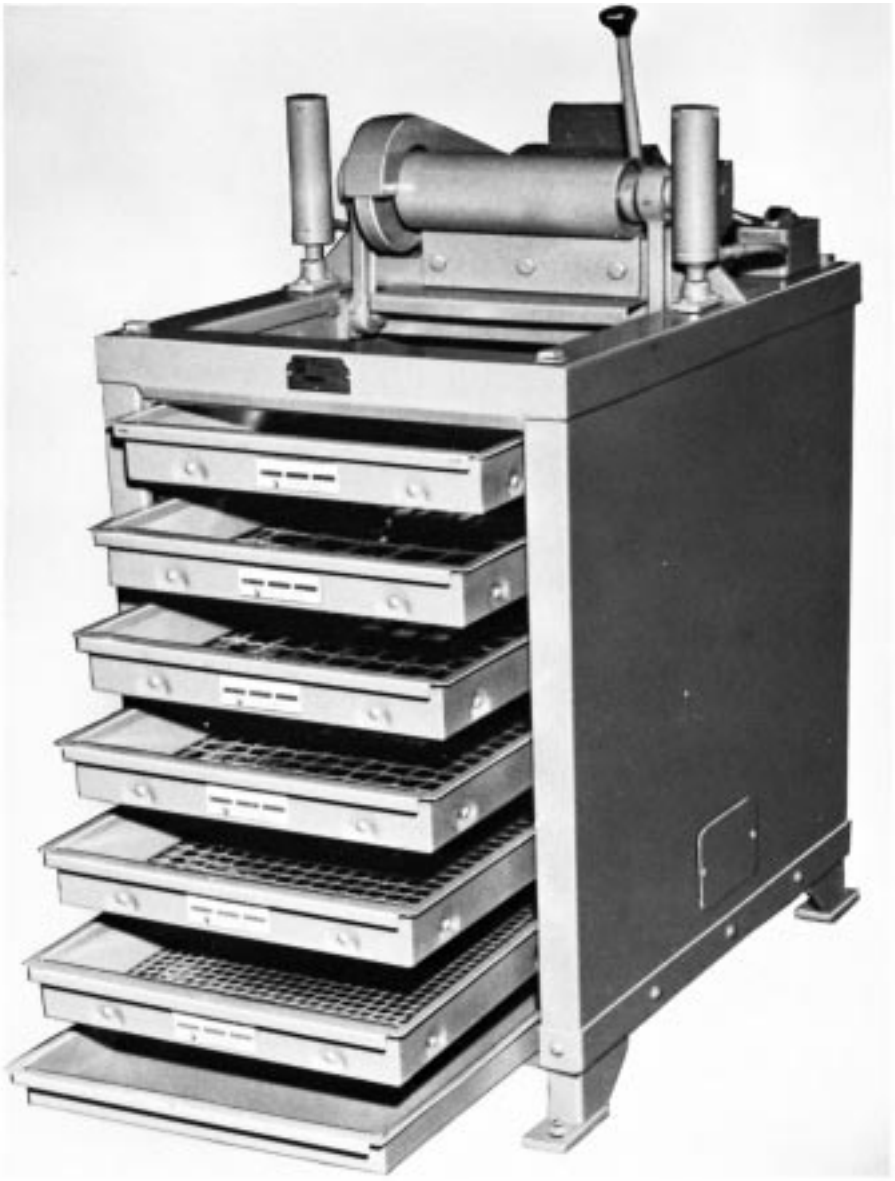


FIG. A1.1 Rectangular Testing Screen

FIG. A1.2 Rotary Pan Sieve

A2. METHOD FOR DETERMINATION OF NOMINAL AND MEAN PARTICLE SIZES

A2.1 Graphical Form

A2.1.1 The graphical form (see Fig. A2.1) is suitable for recording the sieve analysis data, determining the percentage retained, the cumulative percentage, and for plotting the cumulative percentage on the Rosin-Rammler graph.

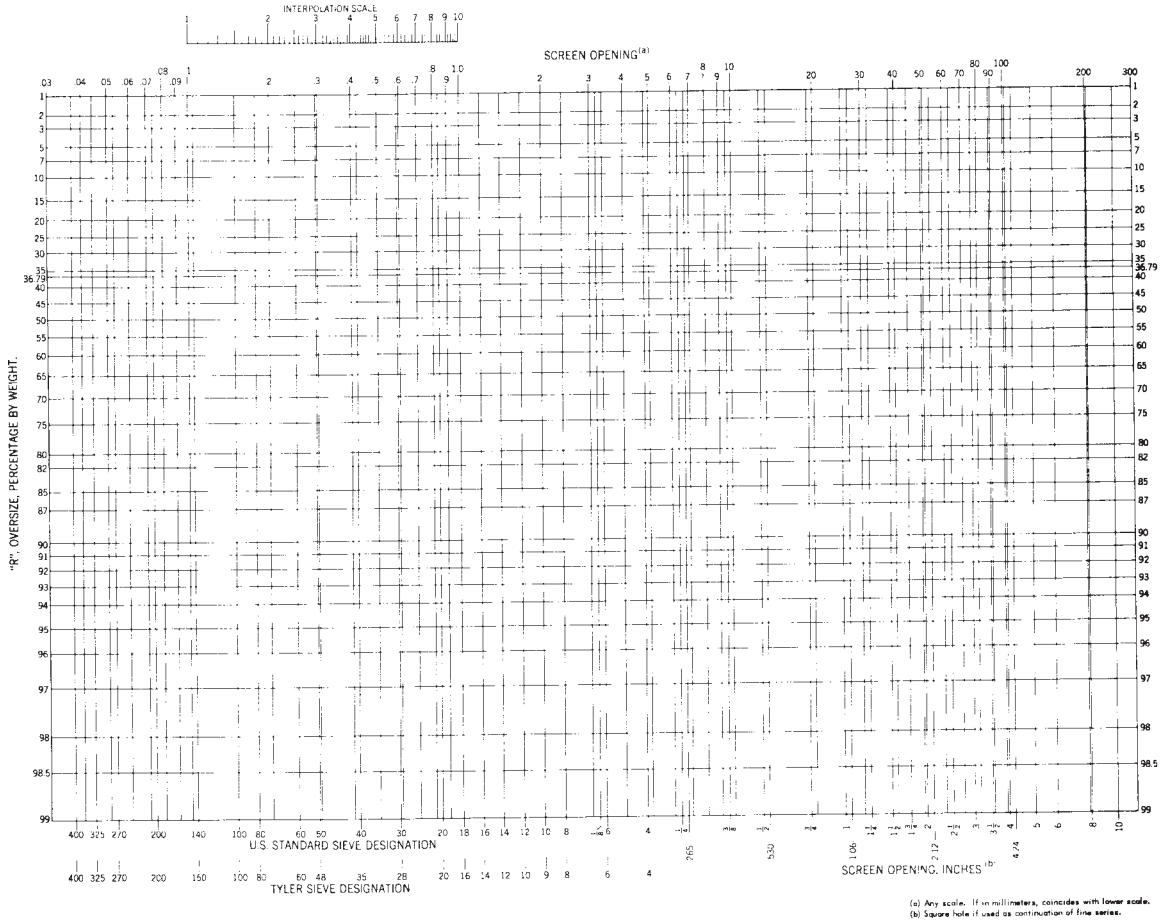
A2.1.2 The characteristics of the size distribution can be determined from the plotted cumulative percentage, resulting in a distribution coefficient n and an absolute constant, or mean particle size x in accordance with the techniques of Rosin-Rammler analysis.

A2.2 Procedure for Determining Coefficients

A2.2.1 Plot "Percent Cumulative Greater than Size" against size on the Graphical Form.

A2.2.2 Note the size retaining 36.79 %. This is the mean particle size. Use the nearest-standard screen opening or mesh designation to describe the mean particle size.

A2.2.3 Draw a straight line through the plotted points, passing through the mean particle size, and extend this line to the upper axis (1 % oversize).



GRAPHICAL FORM FOR REPRESENTING DISTRIBUTION OF SIZES OF BROKEN COAL.

(From: Landers, W.S., and Reid, W.T., A Graphical Form for Applying the Rosin and Rammler Equation to the Size Distribution of Broken Coal: Bureau of Mines Inf. Circular 7346, 1946.)

Average particle size (intersection of size distribution line with 63.21 % passing line)	$\bar{X}$
Slope of size distribution line (tangent of angle)	N

[A] Any scale, if in millimetres, coincides with lower scale.
[B] Square hole if used as continuation of fine series.
[C] From: Landers, W. S., and Reid, W. T., A Graphical Form for Applying the Rosin and Rammler Equation to the Size Distribution of Broken Coal; Bureau of Mines Inf. Circular 7346, 1946. Pristine forms are available from ASTM Headquarters. Order ADJE0828.

FIG. A2.1 Graphical Form for Representing Distribution of Sizes[C]

A2.2.4 Read the size at 5 % oversize. Determine the next larger standard screen opening. This is the "Nominal Top Particle Size" of the sample, defined as the size retaining less than 5 % of the sample.

A2.2.5 Read the size at 85 % oversize. Determine the next smaller standard screen opening. This is the "Nominal Bottom Particle Size."

A2.2.6 Select two points, "A" one screen size less than and "B" one size greater than the mean particle size, lying on the straight line drawn through the plotted points.

A2.2.6.1 Measure the horizontal distance of points A and B from the left axis in mm (or inches), and enter them in the table "characteristics" along with the percentage retained. Take the difference between x and y .

A2.2.6.2 The distribution coefficient, n, is the slope of the line, $\frac{\Delta y}{\Delta x}$.

A2.2.6.3 Measure the horizontal distance, x, of points A and B from the left vertical axis, and record in the table "characteristics."

A2.2.6.4 Measure the vertical distance, y, of points A and B from the bottom axis. Record in the table and subtract the x and y measurements to obtain the differences, Δx and Δy.