~~Designation:D2862–97 (Reapproved 2009)ε1~~ Designation: D2862 – 10

Standard Test Method for
Particle Size Distribution of Granular Activated Carbon[1]

This standard is issued under the fixed designation D2862; 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.

This standard has been approved for use by agencies of the Department of Defense.

~~ε1 NOTE—Subsection 1.3 added editorially in October 2009.~~

1. Scope

1.1 This test method covers the determination of the particle size distribution of granular activated carbon. For the purposes of this test, granular activated carbon is defined as a minimum of 90 % of the sample weight being retained on a 180-μm Standard sieve. A U.S. mesh 80 sieve is equivalent to a 180–μm Standard sieve.

NOTE 1—For extruded carbons, as the length/diameter ratio of the particles increases, the validity of the test results might be affected.

1.2 The data obtained may also be used to calculate mean particle diameter (MPD), effective size, and uniformity coefficient.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3.1 *Exception*—All mass measurements are in SI units 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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D2652 Terminology Relating to Activated Carbon
D2854 Test Method for Apparent Density of Activated Carbon
E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
E300 ~~Practice for Sampling Industrial Chemicals~~ Practice for Sampling Industrial Chemicals
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Summary of Test Method

3.1 A known weight of granular activated carbon is placed on the top sieve of a stacked set of U.S. Standard sieves and shaken under standard conditions for a specific time period, after which the weight percent of the total retained on each sieve and bottom pan is determined.

4. Significance and Use

4.1 It is necessary to know the distribution of particle sizes of granular activated carbon in order to provide proper contact of gases or liquid in a packed bed of the material. Changes in particle size distribution can affect the pressure drop across the bed and the rate of adsorption in a bed of a given size.

4.2 Mean particle diameter is a property of activated carbons that influences pressure drop.

4.3 Effective size and uniformity coefficient are two properties of activated carbons often of interest in municipal water treatment applications where control of particle size is of interest.

[1] This test method is under the jurisdiction of ASTM Committee D28 on Activated Carbon and is the direct responsibility of Subcommittee D28.04 on Gas Phase Evaluation Tests.

~~Current edition approved Sept. 1, 2009. Published September 2009. Originally approved in 1970. Last previous edition approved in 2004 as D2862–97 (2004). DOI: 10.1520/D2862-97R09E01.~~

Current edition approved April 1, 2010. Published July 2010. Originally approved in 1970. Last previous edition approved in 2009 as D2862 – 97 (2009)ε1. DOI: 10.1520/D2862-10.

[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. Apparatus

5.1 *Mechanical Sieve Shaker*[3]—This is a mechanically operated sieve shaker that imparts a uniform rotating and tapping motion to a stack of 8-in. (203-mm or equivalent) sieves as described in 5.2. The sieve shaker should be adjusted to accommodate the desired number of sieves, receiver pan, and sieve cover. The bottom stops should be adjusted to give a clearance of approximately 1⁄16 in. (1.5 mm) between the upper carrying plate stops and the sieve cover plate, so that the sieves will be free to rotate. The sieve shaker shall be powered with 1⁄4-hp (186-W) electric motor producing 1725 to 1750 rpm. The sieve shaker should produce 140 to 160 raps per minute with the striker arm and 280 to 320 rotating motions per minute of the sieve stack. The cover plate shall be fitted with a cork stopper that shall extend 1⁄4 ± 1⁄8 in. (6.35 ± 3.18 mm) above the metal recess. At no time shall any material other than cork be permitted.

5.2 *Sieves*—U.S. Standard sieves or equivalent conforming to Specification E11. The sieves shall be either 2 in. (51 mm) (full height) or 1 in. (25 mm.) (half height) in height, and 8 in. (203 mm or equivalent) in diameter.

5.3 *Bottom Receiver Pan* and *Top Sieve Cover*.

5.4 *Interval Timer*, adjustable, with an accuracy of ±10 s.

5.5 *Sample Splitter*, single-stage riffle type.

5.6 *Balance*, with a sensitivity of 0.1 g.

5.7 *Soft Brass Wire Brush*. [4]

5.8 *Cylinder*, glass, graduated, 250-mL capacity.

5.9 *Equivalent Apparatus*—Newer technology may produce devices that can perform an equivalent function to the mechanical sieve shaker described in 5.1, for which this method was originally developed (Tyler model RX-19–1 or –2). In the case of newer

[3] The Tyler Ro-Tap Model RX-19-1 has been used in developing this test. Newer models may not produce the same separations (Model RX-19-2 is equivalent to Model RX-19-1). This model is available from Fisher Scientific, Pittsburgh, PA 15238.

[4] W. S. Tyler Model 1778-S.B. or equivalent has been found satisfactory.

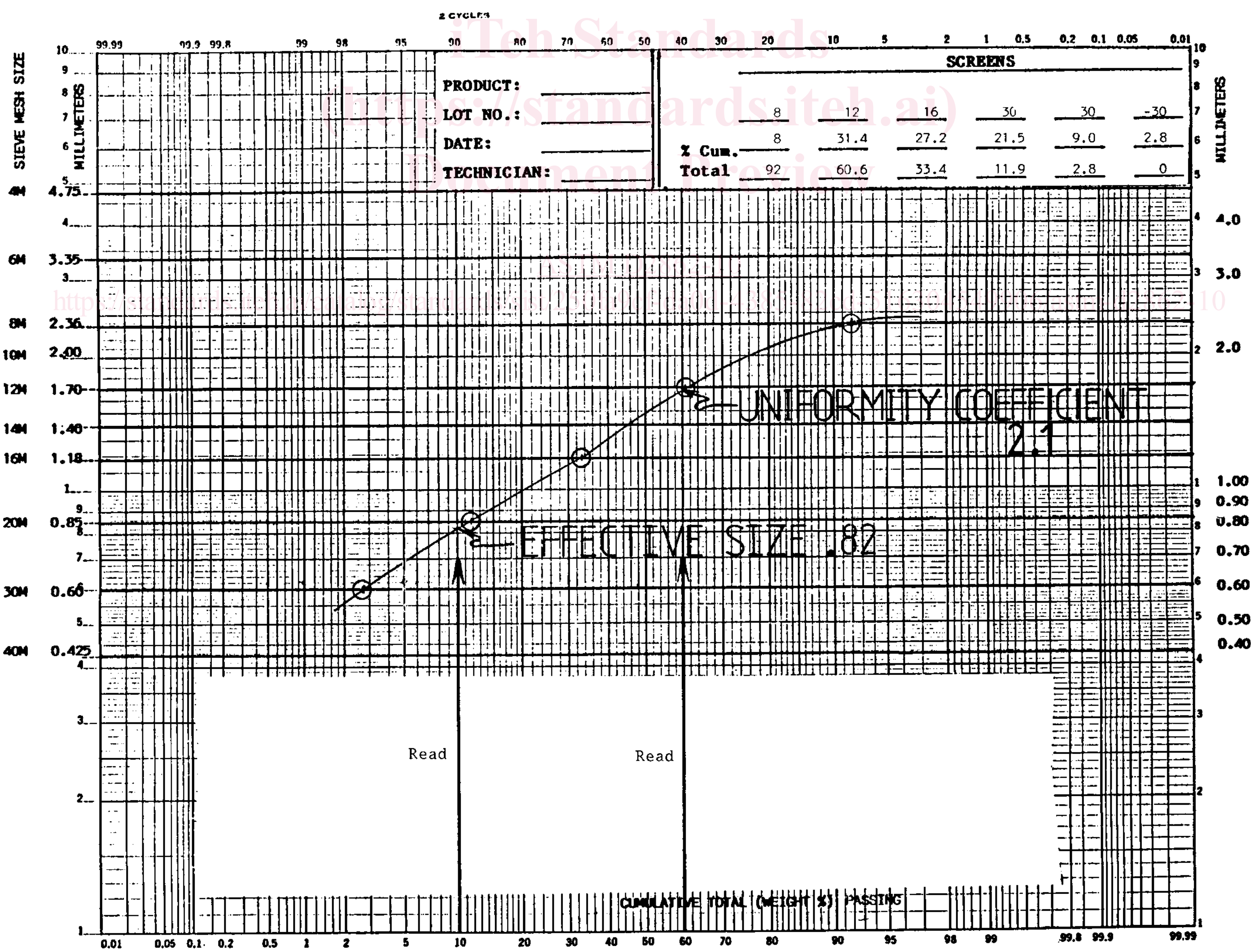

FIG. 1 Cumulative Particle Size Distribution Curve

devices being used, the tester should validate the equivalency of the newer device to that of the ASTM standard tester (or its successors, for example, Tyler model RX-29) and retain the capability to cross check the results of particle size distribution analysis between the mechanical device described above and any newer sieving system.

6. Sampling

6.1 Collect and prepare the granular activated carbon samples in accordance with Practice E300.

7. Procedure

7.1 Stack the sieves to be used on the bottom receiver pan in order of increasing sieve opening from bottom to top.

7.2 Prepare a sample of activated carbon as follows:

7.2.1 Mix the gross sample, obtained by Practice E300, by passing it through a single-stage riffle type sample splitter and recombining twice. Then pass the mixed sample through the riffle so as to obtain an approximate 250-mL of sample.

7.2.2 Using the apparent density apparatus described in Test Method D2854, obtain a test sample of 200 mL from each sample. If the apparent density is less than 0.35 g/cc, a 50 g sample will be adequate, greater than 0.35 g/cc, use a sample not to exceed 100 g. In all cases, volume of the sample should not exceed 200 ml.

NOTE 2—If the apparent density of the sample has been determined, a calculated weight of sample equivalent to 200 ± 10 mL may be used for each of the riffled samples.

7.2.3 Weigh each sample to the nearest 0.1 g.

7.3 . Transfer the weighed sample to the top sieve.

7.4 Install the sieve cover and transfer the assembly to the sieve shaker.

7.5 Allow the sieve assembly to shake for 10 min ± 10 s with the hammer operating.

7.6 Remove the sieve assembly from the sieve shaker and quantitatively transfer, using the sieve brush, the activated carbon retained on the top sieve to a tared weighing pan and weigh to the nearest 0.1 g. Repeat this procedure for material retained on each sieve and the bottom receiver pan.

7.7 Repeat the analysis if desired. Use the repeatability tolerances listed in 10.1 as a guide for precision and bias.

8. Calculation

8.1 Add the weights of each sieve fraction; if the sum deviates more than 2.0 g from the sample weight, the analyses should be repeated.

8.2 Calculate the particle size distribution of each sample to the nearest 0.1 % and the average of the two samples to the nearest 0.1 % as follows:

$$R = (F/S) \times 100$$

where:

F = sieve fraction weight,
S = sum of sieve fraction weights, and
R = percent retained on each fraction.

8.3 If effective mean particle diameter is of interest, it may be calculated from the following equation by using the percent retained in each sieve fraction from the particle size distribution analysis. See Table 1.

TABLE 1 Factors for Calculating the Effective Mean Particle Diameter

U.S.S. Sieve No.	Mean Opening, (N) mm	U.S.S. Sieve No.	Mean Opening, (N) mm
+4	5.74	20 × 30	0.72
4 × 6	4.06	25 × 30	0.65
4 × 8	3.57	30 × 35	0.55
6 × 8	2.87	30 × 40	0.51
8 × 10	2.19	35 × 40	0.46
8 × 12	2.03	40 × 45	0.39
10 × 12	1.84	40 × 50	0.36
12 × 14	1.55	45 × 50	0.33
12 × 16	1.44	50 × 60	0.27
14 × 16	1.30	50 × 70	0.25
16 × 18	1.10	60 × 70	0.23
16 × 20	1.02	70 × 80	0.19
18 × 20	0.92	70 × 100	0.18
20 × 25	0.78	80 × 100	0.16

$$P = R \times N$$

$$\text{Effective MPD (mm)} = \frac{\Sigma P}{100}$$

where:

R	= percent retained in a sieve fraction,
N	= factor for a given sieve fraction (Table 1),
P	= effective mean particle size of a given sieve fraction, and
Effective MPD	= effective mean particle diameter of the sample.

8.3.1 See Table 2 for an example of effective MPD calculation.

8.4 If effective size and uniformity coefficient are of interest, they may be calculated as shown in Table 3 from the cumulative total of the percent passing through each sieve.

8.4.1 Plot the cumulative percentages of the particle size versus the size of the sieve openings in millimeters on probability–logarithmic graph paper (see Fig. 1). The sieve size openings can be obtained from Specification E11. See Table 1.

8.4.2 Determine the effective size by reading the screen size opening in mm corresponding to the point where the curve intersects the 10 % passing value. See Fig. 1.

8.4.3 Calculate the uniformity coefficient by reading the screen size opening in millimetres corresponding to the point where the curve intersects the 60 % passing value and dividing this value by the effective size value from 8.4.2, for example:

$$\text{uniformity coefficient} = \frac{\text{value (mm) @ 60 \% intersection}}{\text{value (mm) @ 10 \% intersection}}$$

NOTE 3—The lower the uniformity coefficient value, the more uniform the granular activated carbon. If all the particles were exactly the same size, the uniformity coefficient would be 1.

9. Report

9.1 Report the following information:

~~9.1.1Source of the sample,~~

~~9.1.2Type or grade designation,~~

9.1.1 Source of the sample,

9.1.2 Type or grade designation,

9.1.3 Name of the carbon supplier,

9.1.4 Supplier lot or batch number, or both,

9.1.5 Nominal particle size,

9.1.6 Particle size distribution,

TABLE 2 Example of Effective MPD Calculation Using 8 × 30 Mesh Material[A,B]

U.S.S. Sieve No.	Percent Retained	Mean Opening (mm)	Weighted Average
+8	8.0	2.87	23.0
8 × 12	31.4	2.03	63.7
12 × 16	27.2	1.44	39.2
16 × 20	21.5	1.02	21.9
20 × 30	9.1	0.72	6.6
	2.8	0.51	1.4
	100.0		155.8

[A]

$$\text{Effective MPD (mm)} = \frac{155.8}{100} = 1.558$$

[B]The mean particle size of each sieve fraction is assumed to be the average of the sieve opening in millimetres through which the material has passed and the sieve opening in millimetres on which the material was retained. In the case of particles larger than those measured, the mean particle size of this fraction is assumed to be the average of the opening of the sieve actually used and that of the next larger sieve in the $\sqrt{2}$ series. In the case of particles smaller than the opening of the smallest sieve, the mean particle size of this fraction is assumed to be the average of the opening of the smallest sieve and that of the next smaller sieve in the $\sqrt{2}$ series. See Table 1 for lists of the mean opening in millimetres for various sieve fractions.