Designation: D 5159 – 91 (Reapproved 1997)

Standard Test Method for Dusting Attrition of Granular Activated Carbon[1]

This standard is issued under the fixed designation D 5159; 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 the dusting attrition of granular activated carbons. For the purpose of this test method, the dust attrition coefficient, *DA*, is defined as the weight (or calculated volume) of dust per unit time, collected on a preweighed glass-fiber filter, in a given vibrating device during a designated time per unit weight of carbon. The initial dust content of the sample may also be determined. Granular activated carbon is defined as a minimum of 90 % being larger than 80 mesh (0.18 mm) (see Test Methods D 2867).

1.2 The values stated in SI units are to be regarded as the standard. The inch-pound units 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.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 2854 Test Method for the Apparent Density of Activated Carbon[2]

D 2867 Test Methods for Moisture in Activated Carbon[2]

E 11 Specification for Wire-Cloth Sieves for Testing Purposes[3]

E 300 Practice for Sampling Industrial Chemicals[4]

3. Summary of Test Method

3.1 A specified volume of known weight of the granular activated carbon is placed in the prescribed sample holder and vibrated at constant acceleration (*g*) for a specified time. The dust is carried by an air stream passing through the vibrating sample and is then collected on a preweighed glass-fiber filter. The quantities of dust collected in six 10-min intervals are determined by weighings on an analytical balance.

4. Significance and Use

4.1 Three forces can mechanically degrade a granular activated carbon: impact, crushing, and attrition. Of these three, attrition, or abrasion, is the most common cause of dust formation in actual service. Published test procedures to determine the "hardness" of activated carbons produce results that in general cannot be correlated with field experience. For example, the ball-pan hardness test applies all three forces to the sample in a variable manner determined by the size, shape, and density of the particles. The "stirring bar" abrasion test measures attrition so long as the particle size is smaller than 12 mesh. There is some evidence, however, that the results of this test method are influenced by particle geometry. This test method measures the effect of friction forces between vibrating or slowly moving particles during the test and may be only slightly dependent on particle size, shape and density effects.

5. Apparatus

5.1 *Vibrating Table*[5], capable of providing an RMS (root mean square) acceleration of 40 m/s/s (4 *g*).

5.2 *Test Cell*, as shown in Fig. 1, made of aluminum.

5.3 *Piezoelectric Accelerometer*[6],, capable of measuring an RMS acceleration of 40 m/s/s (4 *g*), with an output signal between 5 and 20 m V-ac/peak *g*.

5.4 *Signal Conditioner*, [7] to interface the accelerometer with an a-c millivolt meter, capable of producing a linear output voltage from 0 to 100 mV-ac, proportional to the acceleration.

5.5 *Voltmeter*[8], 0 to 100 m-ac.

5.6 *Ammeter*, ac, 0 to 1000 mA accurate to 1 mA.

5.7 *Variable Transformer*, 0 to 120 V.

5.8 *Timer Control*, 0 to 120 min.

5.9 *Isolation Pad*, cross-ribbed 9.5 mm (⅜ in.) thick by 100 mm (3.94 in.) square constructed from 45 durometer neoprene rubber.

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[1] This test method is under the jurisdiction of ASTM Committee D-28 on Activated Carbon and is the direct responsibility of Subcommittee D28.04 on Gas Phase Evaluation Tests.

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[2] *Annual Book of ASTM Standards*, Vol 15.01.

[3] *Annual Book of ASTM Standards*, Vol 14.02.

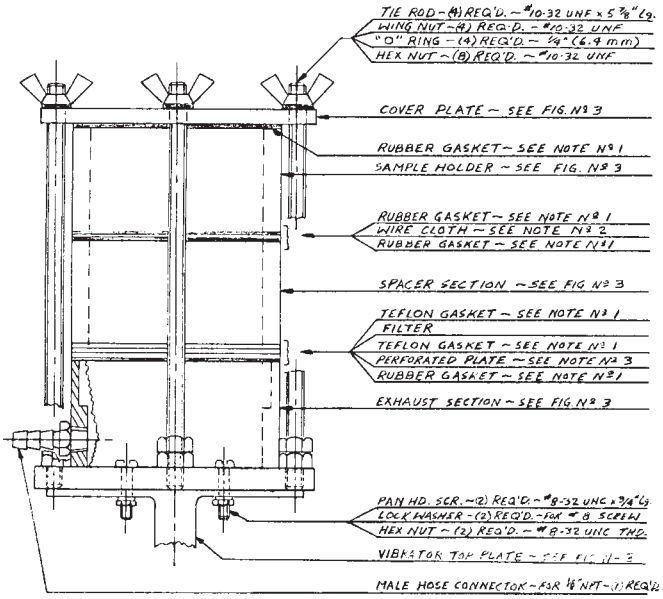
[4] *Annual Book of ASTM Standards*, Vol 15.05.

[5] A Buffalo Dental Manufacturing Co., (Underhill Blvd., Syosset, NY 11791) vibrator, Model No. 1, rated 40 W at 115 V, 60 Hz, and a Syntron Model J-1A vibrating jogger, rated 30 W at 115 V, 60 Hz, have been found suitable for this purpose.

[6] An Endevco accelerometer, Model No. 2251, has been found suitable for this purpose.

[7] An Endevco Model 4416 signal conditioner, battery operated, has been found suitable for this purpose.

[8] A Keithley 179 digital multimeter, available from Keithley Instruments, Aurora Rd., Cleveland, OH 44139, has been found suitable for this purpose.



NOTE 1—2¾ in. (69.9 mm) inside diameter by 3 in. (76.2 mm) outside diameter by 1⁄16 in. (1.6 mm) thick.

NOTE 2— Specification E 11 wire cloth, 250 µm, stainless wire, 3 in. (76.2 mm) diameter.

NOTE 3—37 % open area, fabricated from 24 gage stainless steel with 0.45 in. (11.4 mm) diameter holes on 0.066 in. (1.68 mm) centers, square grid 3 in. (76.2 mm) diameter.

FIG. 1 Dust Attrition Cell (full scale)

5.10 *Flowmeter*, with flow control valve having a capacity from 1 to 12 L/min.

5.11 *Glass-Fiber Filter*, 75 mm in diameter, having an efficiency of 99.9 % for 0.3 µm particles. Several commercial glass fiber filters have been found satisfactory.

5.12 *Graduated Cylinder*, 100 mL capacity.

5.13 *Analytical Balance*, capable of weighing to 0.1 mg.

6. Sampling, Test Specimens, and Test Units

6.1 Guidance in sampling granular activated carbon is given in Practice E 300 (see also 8.1).

7. Preparation of Apparatus

7.1 Assemble the test cell, that has an outside diameter of 76.2 mm (3 in.) and an inside diameter of 69.9 mm (2¾ in.), as shown in Fig. 1. Components of the test cell that must be fabricated are shown in Fig. 2 .

7.2 Glue the wire cloth for the bottom of the top section between two rubber gaskets and then glue this assembly to the bottom of the section to form the sample holder.

7.3 Mount the accelerometer crystal at the center of the cover plate, either by cement or by using a No. 52 cap screw.

7.4 Place the vibrator test assembly on the vibration isolation pad so that the cover plate of the test cell is level.

7.5 Connect the accelerometer lead to the signal conditioner, then connect the output of the signal conditioner to the microvolt meter (see Fig. 3).

7.6 Connect the vibrator to the variable transformer and connect the transformer to a timer control with the milliammeter in series (see Fig. 3).

7.7 Connect the air outlet of the attrition test cell to the flowmeter, and connect the flowmeter to a vacuum source (see Fig. 3).

8. Procedure

8.1 Measure 100 mL of the sample into a tared, graduated cylinder using the method and apparatus described in Test Method D 2854 and weigh to the nearest 0.1 g. If the average nominal particle size of the sample is less than 12 mesh, a 50 mL sample may be used.

8.1.1 Reproducibility in duplicate or quadruplicate determinations may be improved by taking two or four times the volume of the given sample and making one subdivision by careful coning and quartering.

8.1.2 A second convenient procedure is to use a miniature sample divider and divide the sample once or twice as desired. Mount Micro splitter[9] for mineral sampling on a vibrating table to ensure an equal division of all particles, especially the fines.

8.2 Calculate the apparent density of the sample using Test Method D 2854.

8.3 Quantitatively transfer the sample into the sample holder section of the test cell.

8.4 Weigh the glass filter element to 0.1 mg.

8.5 Insert the weighed glass filter *rough side up* between the two flat TFE flourocarbon gaskets and place in position on top of the exhaust section of the test cell. Handle the glass filter with care to avoid tearing.

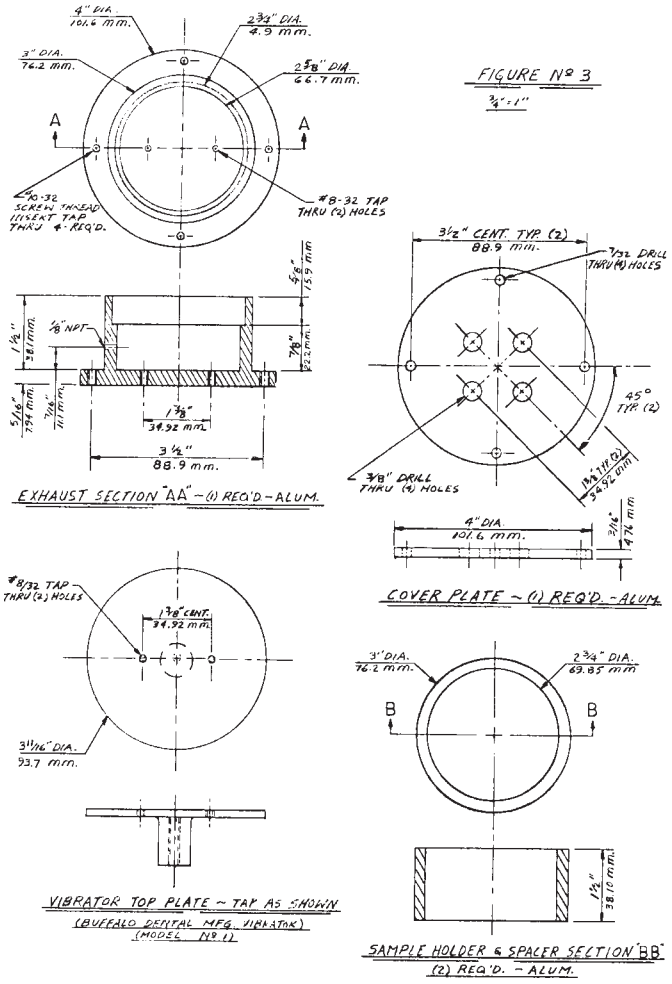
8.6 Place the spacer section of the test cell in position.

8.7 Place the sample holder of the test cell in position.

8.8 Place a rubber gasket on top of the sample holder, then position the cover plate through the four threaded rods.

8.9 Place O-rings or flat washers on the threaded rods and secure the test cell assembly to the vibrator table by threading the wing nuts to finger tightness.

[9] Available from SEPOR, Inc. P.O. Box 578, Wilmington, CA 90748.



NOTE 1—A Model No. 1 vibrator available from Buffalo Dental Mfg., Underhill Blvd., Syosset, NY 11791, has been found suitable for this purpose.

FIG. 2 Test Cell Components Requiring Fabrication (¾ in. = 1 in. scale)

8.10 With the vibrator control always set at the *high* range position, set the timer control to 10 min.

8.11 Start the air flowing, then adjust to draw 7 L/min of air through the sample.

8.12 Increase the voltage to the vibrator from "zero" to produce a RMS acceleration of 40 m/s/s, (4 *g*). Alternatively, the vibrator current may be adjusted to the value determined by a calibration using the accelerometer; however, the latter requires frequent calibration.

8.13 Vibrate the sample for 10 min.

8.14 Remove the wing nuts, cover plate, sample holder, and spacer section of the test cell to expose the filter element.

8.15 Carefully remove and weigh the glass filter to 0.1 mg.

8.16 Insert a second weighed glass filter.

8.17 Before returning the sample holder, place a flat piece of glass over the top and hold firmly in place while slowly inverting the sample three times in order to re-distribute particles that may have become bed-locked or segregated during vibration.

8.18 Repeat 8.4 and 8.17 for a total of six 10-min vibration intervals.

9. Calculation

9.1 Calculate the total dust collected during the following designated time intervals:

Interval, min	Weight, mg	Integrated Time, min	Integrated Weight, mg
0–10	w_1	10	w_1
10–20	w_2	10	w_2
20–30	w_3	20	$w_2 + w_3$
30–40	w_4	30	$w_2 + w_3 + w_4$
40–50	w_5	40	$w_2 + w_3 + w_4 + w_5$
50–60	w_6	50	$w_2 + w_3 + w_4 + w_5 + w_6$

9.2 Using the integrated time intervals as *x*-coordinate and the corresponding total dust as *y*-coordinate, and excluding the first 10 min interval, calculate a least square linear regression on the five pairs of X_i, Y_i; where: $i = 2, 3, 4, 5, 6$.

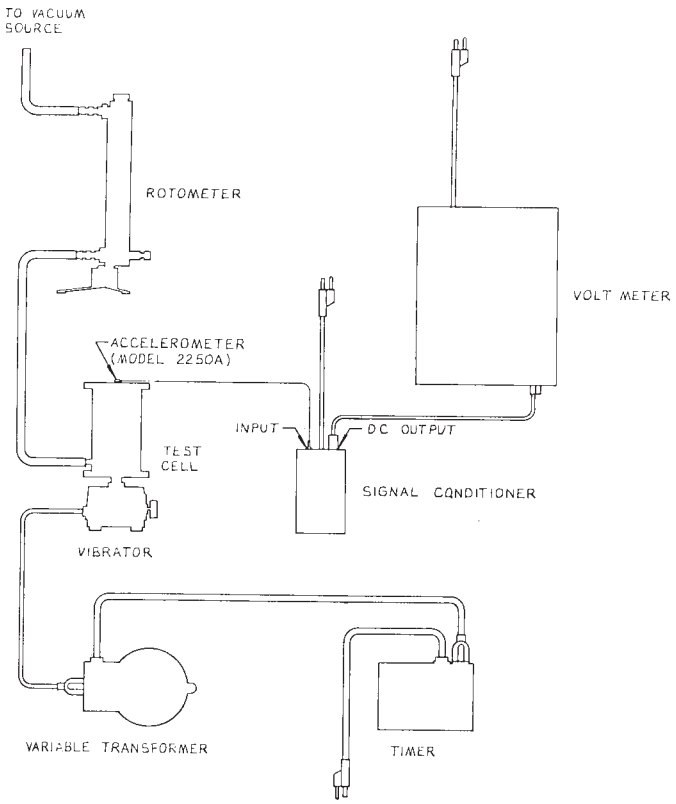
9.3 The slope is the dust attrition, *DA*, in mg/min; calculate the correlation coefficient.

9.4 The regression coefficient, R^2, should be at least 0.95. If this is not the case, the test should be repeated.

9.5 Calculate the initial dust content, $DU = w_1 - 10\ DA$.

9.6 Calculate the dust attrition coefficient by volume, *DA* (*V*) from the following equation:

$$DA\ (V) = DA\ (W)/\text{apparent density, } \mu\text{L/min} \quad (1)$$



NOTE 1—An Endevco accelerator, Model 2250A, has been found satisfactory for this purpose.

FIG. 3 Apparatus Assembly

where:
apparent density is expressed as mg/µL.

10. Report

10.1 Report the following information:
10.1.1 Name of the carbon supplier,
10.1.2 Grade or type designation of the sample,
10.1.3 Particle size range,
10.1.4 Lot and batch number,
10.1.5 Dust attrition coefficients,
10.1.6 Initial dust, and
10.1.7 Name of the agency and technician making the test.

11. Precision and Bias

11.1 The precision and bias of this test method has not been determined. A round-robin test series is being planned.

12. Keywords

12.1 activated carbon; attrition; dusting; granular