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Standard Guide for Dusting Attrition of Granular Activated Carbon[1]

This standard is issued under the fixed designation D5159; 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 guide presents a procedure for evaluating the resistance to dusting attrition of granular activated carbons. For the purpose of this guide, the dust attrition coefficient, DA, is defined as the weight (or calculated volume) of dust per unit time, collected on a preweighed 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 D2867).

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 guide 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 guide 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]

D2854 Test Method for Apparent Density of Activated Carbon

D2867 Test Methods for Moisture in Activated Carbon

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

E300 Practice for Sampling Industrial Chemicals

3. Summary of Guide

3.1 A known volume of known weight of the granular activated carbon is placed in a sample holder and vibrated at constant acceleration (*g*) for a known time. The dust is carried by an air stream passing through the vibrating sample and is then collected on a preweighed 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. The procedure set forth in this guide 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*[3], capable of providing an RMS (root mean square) acceleration of 40 m/s/s (4 *g*).

5.2 *Test Cell,* such as shown in Fig. 1, preferably made of aluminum or other electrically conductive material.

5.3 *Piezoelectric Accelerometer*[4], capable of measuring an RMS acceleration chosen by the user. A value of 40 m/s/s (4 *g*) is suitable when using the apparatus in Fig. 1 and Fig. 2.

5.4 *Signal Conditioner*[5], to interface the accelerometer with an AC millivolt meter, capable of producing a linear output voltage from 0 to 1 V-ac, proportional to the acceleration.

[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.

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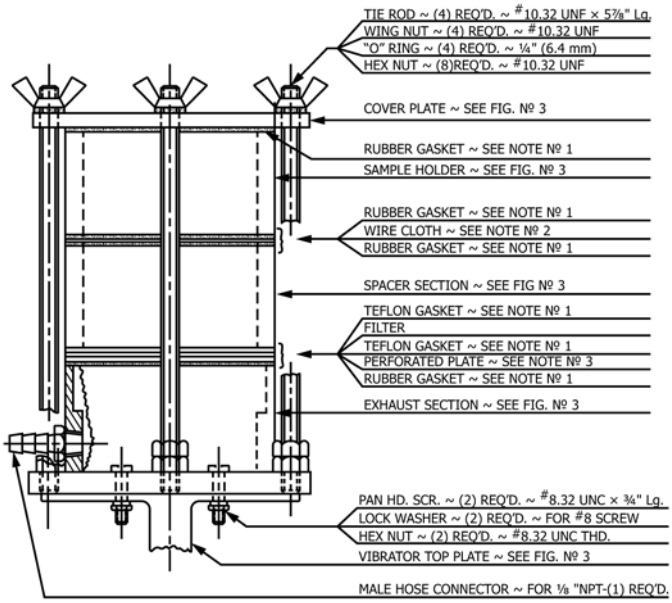
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] 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.

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

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

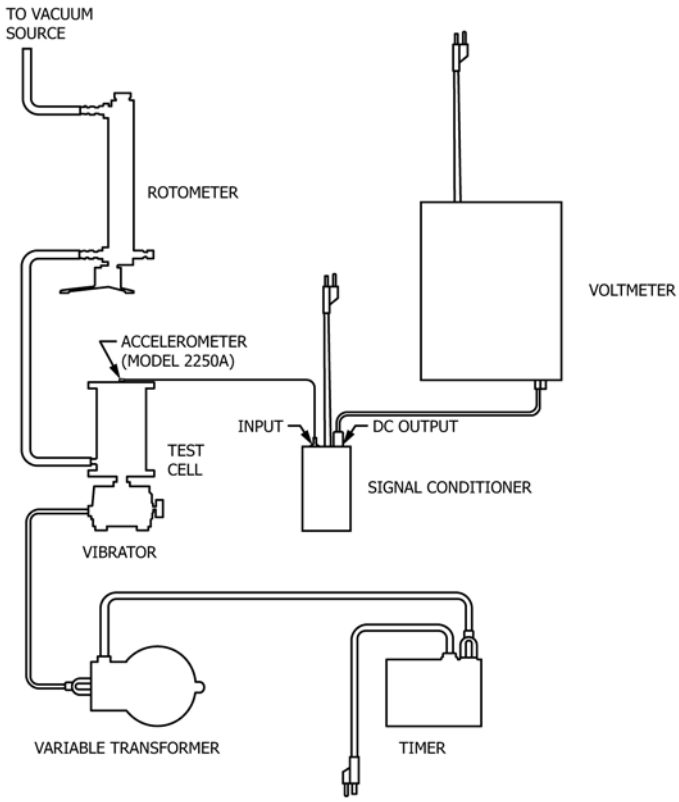


NOTE 1—2¾ in. (69.9 mm) inside diameter by 3 in. (76.2 mm) outside diameter by 1⁄16 in. (1.6 mm) thick.

NOTE 2— Specification E11 wire cloth, 250 µm, stainless wire, 3 in. (76.2 mm) diameter.

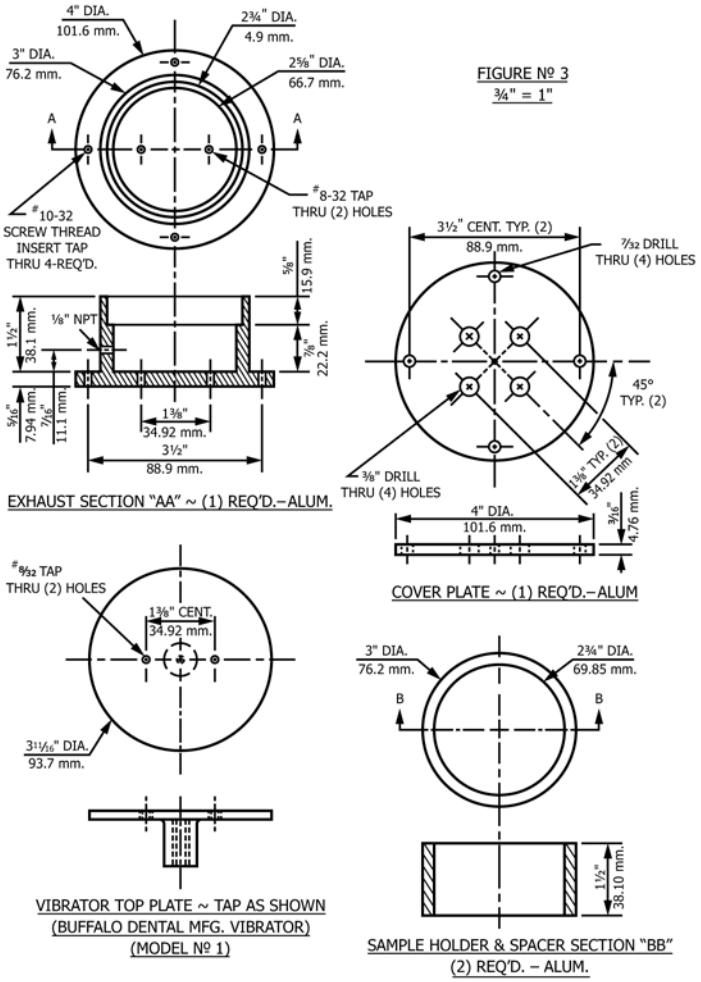
NOTE 3—37 % open area, fabricated from 24 gage stainless steel with 0.45 in. (11.4 mm) diameter holes on 0.066 in. (1.68 mm) centers, square grid 3 in. (76.2 mm) diameter.

FIG. 1 Dust Attrition Cell (full scale)



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

FIG. 2 Apparatus Assembly



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

5.5 *Voltmeter*[6], 0 to 1 V-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 *Rubber Isolation Pad,* a 45 durometer neoprene rubber pad has been found satisfactory.

5.10 *Flowmeter,* with flow control valve capable of controlling air flow at the flow rate chosen by the user of this guide. A flow of about 7 L/min is suitable when using the apparatus of Fig. 1 and Fig. 2.

5.11 *Particulate Filter,* sized to interface with test cell, capable of capturing carbon fines. Several commercial glass fiber filters have been found satisfactory. Also effective are the particulate filters sold for respiratory protection against paint spray or other particulate hazards.

5.12 *Graduated Cylinder,* 100 mL capacity.

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

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

6. Sampling, Test Specimens, and Test Units

6.1 Guidance in sampling granular activated carbon is given in Practice E300 (see also 8.1).

7. Preparation of Apparatus

7.1 Assemble a test cell similar to that shown in Fig. 1 and Fig. 2.

7.2 Mount the accelerometer at the center of the cover plate.

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

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

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 a known volume (about 100 mL) of the sample into a tared, graduated cylinder using the method and apparatus described in Test Method D2854 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 preferred.

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[7] 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 D2854.

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

8.4 Weigh the particulate filter to 0.1 mg.

8.5 IInsert the weighed particulate filter into the apparatus.

8.6 Assemble the test cell assembly and secure it to the vibrator table.

8.7 Set the timer control to 10 minutes. Note - 10 minutes is used only as an example to illustrate the procedure for calculating DA in Section 9. The user of this guide may select another time interval.

8.8 Start the air flowing, then adjust to draw the desired volumetric flow of air through the sample.

8.9 Increase the voltage to the vibrator from "zero" to produce the RMS acceleration chosen by the user. An acceleration value of about 40 m/s/s, (4 *g*) is often used.

8.10 Vibrate the sample for 10 min or other period (see).

8.11 Carefully remove and weigh the particulate filter to 0.1 mg.

8.12 Insert a second weighed particulate filter.

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

8.14 Repeat through 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:

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

where:
apparent density is expressed as mg/µL.

10. Keywords

10.1 activated carbon; attrition; dusting; granular

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