Designation: D5158 − 23

Standard Test Method for Determination of Particle Size of Fine Mesh and Powdered Activated Carbon by Air-Jet Sieving[1]

This standard is issued under the fixed designation D5158; 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 particle size of powdered activated carbons using an air-jet sieve device. For purposes of this test method, powdered activated carbon is defined as activated carbon in particle sizes predominantly in a range of 80 mesh (0.180 mm) through 500 mesh (0.025 mm).

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D2652 Terminology Relating to Activated Carbon
D2867 Test Methods for Moisture in 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
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Terminology

3.1 *Definitions*—Terms relating to this test method are defined in Terminology D2652.

4. Summary of Test Method

4.1 A sample of fine mesh or powdered activated carbon is placed on a test sieve that is inserted in the sieve holder of the air-jet sieve assembly. Air is passed through the sieve from a slowly rotating nozzle to fluidize the sample for a given period of time. Exit airflow removes undersized particles downward through the test sieve to a collection canister. The amount of carbon retained on the test sieve is weighed and the percent passing the test sieve is computed by difference. For a particle size distribution, the test must be repeated using sieves with different openings.

5. Significance and Use

5.1 The particle size of fine mesh and powdered activated carbon is sometimes used to evaluate filter cake filtration rates and the filter penetration in filtering applications.

5.2 The selection and handling of fine mesh or powdered activated carbon, and operation of processes using fine mesh or powdered activated carbon, requires the knowledge of the particle size.

5.3 This test method is intended for single sieve testing only. For determination of particle size distribution of a sample, the test must be repeated using sieves with different openings.

NOTE 1—Relative humidity (RH) can affect the repeatability and accuracy of this test. Activated carbon not at equilibrium with the RH of the ambient air may lose or gain weight accordingly, dependent upon whether the carbon picks up or loses moisture.

6. Apparatus

6.1 *Air-Jet Sieve Assembly.*

6.2 *Wire Cloth Sieves,* bronze or stainless steel (stainless steel sieves preferred), 80 mesh (0.180 mm) through 500 mesh (0.025 mm) in accordance with Specification E11. The sieves shall be 203 mm (8 in.) in diameter.

6.3 *Brush,* soft bristle.

[1] This test method is under the jurisdiction of ASTM Committee D28 on Activated Carbon and is the direct responsibility of Subcommittee D28.02 on Liquid Phase Evaluation.

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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.

6.4 *Balance,* with a sensitivity of 1.0 mg.

6.5 *Ultrasonic Bath,* capable of cleaning 203 mm (8 in.) diameter sieves is recommended but not required.

7. Sampling

7.1 Activated carbon is not strictly a chemically and physically homogeneous material. To enable performing meaningful tests within the stated tolerances of the ASTM test methods, it is essential that sampling be performed to obtain as representative a sample as possible. When a small amount of sample represents tons of material, the collection, mixing, and preparation of samples is extremely important. The practice described in Practice E300 is suitable to ensure that sampling and sample preparation of activated carbon is appropriate for the performance of this test method. In absence of following Practice E300, a detailed specific sampling and sample preparation procedure suitable to the parties involved needs to be prepared.

8. Procedure

8.1 Sieves to be used for the testing should be carefully inspected prior to use and replaced if damaged. Sieves should also be cleaned routinely to remove entrapped particles. Due to the potential for wire cloth damage for sieve sizes used in this test, the use of an ultrasonic bath to clean sieves is recommended. These units are readily available from multiple suppliers in the market.

8.1.1 To properly clean a test sieve, brush the underside of the wire cloth in a circular motion, exerting light pressure to dislodge near-size particles.

8.1.2 Tap the sieve frame with a wooden handle of the brush to dislodge particles. Be careful to not damage the sieve frame.

8.1.3 Wash the sieve in warm soapy water solution to remove near-size particles lodged in the mesh. Brush the underside of the sieve carefully in the warm water.

8.1.4 An ultrasonic cleaner can be used to clean sieves of very fine mesh sizes. If using an ultrasonic cleaner, immerse the sieve in the water and detergent solution. The ultrasonic agitation will ease the removal of near-size particles.

8.2 Determine the size of the test sample in accordance with *ASTM STP 447B*.[3] In deciding on the size of a test sample, consideration must be given to the character of the material, its screening ability, and the range of particle sizes present.

8.3 Dry the sample in accordance with Test Methods D2867. Cool the dry carbon to room temperature in a desiccator. The sample is oven-dried to minimize any error that may be introduced by moisture pick-up of finer particles during the sample preparation step.

8.4 Weigh the established weight of a representative sample of fine mesh or powdered activated carbon, which has been taken and prepared in strict accordance with Practice E300 or a mutually agreed upon sampling and sample preparation procedure, to the nearest 10 mg and record.

NOTE 2—A 10 g sample has been satisfactory for some types of fine mesh or powdered activated carbon. Samples smaller than 10 g may produce inconsistent results. For greater accuracy, it is advisable to control laboratory environmental conditions and to pre-equilibrate carbon samples.

8.5 Transfer the weighed sample into the required wire cloth test sieve that has previously been placed in the sieve holder of the air-jet sieve assembly. The material should be evenly distributed over the entire sieve.

8.6 Install the plastic sieve cover on the test sieve.

8.7 Allow the air-jet sieve to operate for 10 min ± 10 s at a pressure drop greater than 152 mm (6 in.) H_2O.

8.8 When the air-jet sieve has stopped, remove the plastic cover and carefully brush any material adhering to the cover into the sieve.

NOTE 3—Static electricity that can affect the repeatability and accuracy of this test may be generated during the testing. If it is apparent that an excessive amount of material was adhering to the plastic cover, repeat 8.7 of this procedure.

8.9 Remove the test sieve from the air-jet assembly and quantitatively transfer the material into a weighing pan, weigh to the nearest 1.0 mg, and record.

9. Calculation

9.1 Calculate the percent passing through the test sieve as follows:

$$P, \%\ \text{passing} = \frac{(S - R)}{S} \times 100$$

where:

P = percent of sample passing through the test sieve,
R = weight of sample remaining on test sieve, g, and
S = weight of sample used, g.

10. Report

10.1 Report the following information:

10.1.1 Source of the sample,

10.1.2 Type or designation of the powdered activated carbon,

10.1.3 Name of the carbon supplier,

10.1.4 Supplier grade designation,

10.1.5 Supplier lot and batch number,

10.1.6 Particle size (percent passing the test sieve designation),

10.1.7 Name of the agency and technician making the test, and

10.1.8 Sample identification number and the date of the test.

11. Precision and Bias[4]

11.1 The precision of this test method is based on an interlaboratory study of ASTM D5158, Test Method for Determination of Particle Size of Fine Mesh and Powdered Activated Carbon by Air Jet Sieving, conducted in 2020. Each of ten volunteer laboratories were asked to test eight different

[3] *Manual on Test Sieving Methods, ASTM STP 447B*, ASTM International, West Conshohocken, PA, 1985, pp. 9–10.

[4] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D28-2001. Contact ASTM Customer Service at service@astm.org.

materials. Every "test result" represents an individual determination, and all participants were instructed to report three replicate test results for each material. Practice E691 was followed for the design and analysis of the data; the details are given in an ASTM Research Report.

11.1.1 *Repeatability Limit (r)*—The difference between repetitive results obtained by the same operator in a given laboratory applying the same test method with the same apparatus under constant operating conditions on identical test material within short intervals of time would in the long run, in the normal and correct operation of the test method, exceed the following values only in one case in 20.

11.1.1.1 Repeatability can be interpreted as the maximum difference between two results, obtained under repeatability conditions, that is accepted as plausible due to random causes under normal and correct operation of the test method.

11.1.1.2 Repeatability limits are listed in Tables 1-4.

11.1.2 *Reproducibility Limit (R)*—The difference between two single and independent results obtained by different operators applying the same test method in different laboratories using different apparatus on identical test material would, in the long run, in the normal and correct operation of the test method, exceed the following values only in one case in 20.

11.1.2.1 Reproducibility can be interpreted as maximum difference between two results, obtained under reproducibility conditions, that is accepted as plausible due to random causes under normal and correct operation of the test method.

11.1.2.2 Reproducibility limits are listed in Tables 1-4.

11.1.3 The terms repeatability limit and reproducibility limit are used as specified in Practice E177.

11.1.4 Any judgment in accordance with statement 11.1.1 would normally have an approximate 95 % probability of being correct, however the precision statistics obtained in this ILS must not be treated as exact mathematical quantities which are applicable to all circumstances and uses. The limited number of laboratories reporting replicate results essentially guarantees that there will be times when differences greater than predicted by the ILS results will arise, sometimes with considerably greater or smaller frequency than the 95 % probability limit would imply. Consider the repeatability limit as a general guide, and the associated probability of 95 % as only a rough indicator of what can be expected.

11.2 *Bias*—At the time of the study, there was no accepted reference material suitable for determining the bias for this test method, therefore no statement on bias is being made.

11.3 The precision statement was determined through statistical examination of 393 results, from 10 laboratories, on 7 materials.

12. Keywords

12.1 activated carbon; powdered activated carbon

TABLE 1 Greater or Equal to 95 % 200 US Mesh (Grams)

Material	Number of Laboratories	Average[A]	Repeatability Standard Deviation	Reproducibility Standard Deviation	Repeatability Limit	Reproducibility Limit
	n	$\bar{x}$	s_r	s_R	r	R
Wood PAC 1	10	99.88	0.15	0.26	0.41	0.73
Bituminous Coal PAC 1	10	99.78	0.12	0.35	0.34	0.99
Lignite PAC	9	99.63	0.20	0.25	0.55	0.69
Wood PAC 2	9	98.03	0.51	0.51	1.43	1.43
Coconut PAC 1	8	96.96	0.40	0.63	1.13	1.77
Coconut PAC 2	8	99.56	0.43	0.49	1.20	1.38

[A] The average of the laboratories' calculated averages.