



Standard Test Methods for Physical and Chemical Properties of Powdered Ion Exchange Resins¹

This standard is issued under the fixed designation D 4456; 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 These test methods cover the determination of the physical and chemical properties of powdered ion exchange resins and are intended for use in testing new materials. The following test methods are included:

	Sections
Test Method A—Particle Size Distribution	5 to 15
Test Method B—Solids Content	16 to 23

1.2 *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 consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

D 1129 Terminology Relating to Water²

D 1193 Specification for Reagent Water²

D 2687 Practices for Sampling Particulate Ion-Exchange Materials³

D 2777 Practice for Determination of Precision and Bias of Applicable Methods of Committee D-19 on Water²

F 322 Method for Determining Quality of Calibration Particles for Automatic Particle Counters⁴

F 651 Method for Particle Counter Single-Point Calibration by the Median Method⁵

F 658 Practice for Defining Size Calibration, Resolution, and Counting Accuracy of Liquid-Borne Particle Counter Using Near-Monodisperse Spherical Particulate Material⁶

3. Terminology

3.1 *Definitions*—For definitions of terms used in this practice, refer to Terminology D 1129.

3.2 *Definitions of Terms Specific to This Standard*: Certain terms that relate specifically to these test methods are described as follows:

3.2.1 *powdered ion exchange resin*—an ion exchange resin that has undergone post-manufacturing size reduction to less than 30 μm.

3.2.2 *resin floc*—that voluminous aggregate formed when powdered anion exchange resin and powdered cation exchange resin are slurried together in an aqueous suspension.

4. Purity of Reagents

4.1 Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society,⁷ where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

4.2 *Purity of Water*— Unless otherwise indicated, references to water shall be understood to mean Type III reagent water, Specification D 1193.

TEST METHOD A—PARTICLE SIZE DISTRIBUTION

5. Scope

5.1 This test method covers the instrumental determination of the particle-size distribution of powdered ion exchange resins.

¹ These test methods are under the jurisdiction of ASTM Committee D-19 on Water and are the direct responsibility of Subcommittee D19.08 on Membranes and Ion Exchange Materials.

Current edition approved June 10, 1999. Published September 1999. Originally published as D 4456–85. Last previous edition D 4456–85 (1990).

² *Annual Book of ASTM Standards*, Vol 11.01.

³ *Annual Book of ASTM Standards*, Vol 11.02.

⁴ Discontinued—See 1989 *Annual Book of ASTM Standards*, Vol 14.02.

⁵ Discontinued—See 1986 *Annual Book of ASTM Standards*, Vol 15.03.

⁶ *Annual Book of ASTM Standards*, Vol 15.03.

⁷ *Reagent Chemicals, American Chemical Society Specifications*, American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmaceutical Convention, Inc. (USPC), Rockville, MD.



6. Summary of Test Method

6.1 A sample of powdered ion exchange resin is dispersed uniformly in a suitable aqueous liquid. The resulting suspension is passed through an instrument for measuring particle size distribution by weight, number, or volume. Determinations are made of mean particle size, percent below a specified smaller size limit, and percent above a specified larger size limit.

6.2 The analyst should be aware that adequate collaborative data for precision and bias statements as required by Practice D 2777 are not provided. See Section 15 for details.

7. Significance and Use

7.1 The particle size distribution of powdered ion exchange resins and, more importantly, the derived parameters of mean particle size and percent above and below specified size limits are useful for determining batch to batch variations and, in some cases, can be related to certain aspects of product performance.

7.2 Although automatic multichannel particle size analyzers, of the type described in Section 9, yield information on the entire distribution of sizes present in a given sample, it has been found that, for this application, the numerical value of three derived parameters may adequately describe the particle size characteristics of the samples: the mean particle diameter (in micrometres), the percent of the sample that falls below some size limit, and the percent of the sample that falls above some size limit.

8. Interferences

8.1 Instruments requiring the use of an aqueous electrolyte for sample suspension, such as described in 9.1.2, may give results different than those instruments not requiring an electrolyte.

9. Apparatus

9.1 *Instruments for Measuring Particle Size Distribution*,⁸ from 2 to 300 μm in size, although it may not be necessary to cover this entire range for any one sample. Satisfactory results have been obtained from instruments with three different principles of operation. Instruments from other manufacturers may be suitable but have not been evaluated.

9.1.1 *Optical Particle Counters*, that pass a collimated light beam through a flowing stream of particles to measure and count each individual particle according to the reduction in light intensity created as it passes through the sensing zone.

9.1.2 *Electrical Resistance Particle Counters*, that set up a voltage difference across an aperture through which a conductive liquid flows to measure and count each particle in the liquid by the change in conductivity or resistance as it passes through the aperture.

9.1.3 *Light-Scattering Instruments*, that view a flowing stream of particles with a laser beam and produce a Fraunhofer

diffraction pattern from which a thirteen-segment histogram of volume size distribution is obtained.

9.2 *Sample Handling System*, compatible with the particle-sizing instrument being used.

9.3 *Auxiliary Equipment*, as specified by the manufacturer of the instrument being used.

10. Material

10.1 *Nonionic Wetting Agent*, to assist in the dispersion of the particles in the liquid. The volume to be added will be small, but its cleanliness should be such that the total count in the suspending liquid (with wetting agent) does not exceed 1 % of the total count during analysis of the resin sample.

11. Calibration and Standardization

11.1 Calibrate the instrument over the size range to be measured following either the manufacturer's instructions or Method F 651, Practice F 658, or Method F 322.

12. Procedure

12.1 Into a clean sample container, add measured quantities of clean liquid, clean wetting agent, and a sample of powdered ion exchange resin. The size of the sample container and the quantities of each material to be added will be determined from the operating instructions for the instrument being used for the size range to be measured.

12.2 Agitate the resulting suspension to break up agglomerates and create a uniform dispersion of particles using the equipment specified in the operating instructions for the instrument.

12.3 If necessary, dilute this suspension to provide a concentration of particles not exceeding the maximum specified for proper instrument performance.

12.4 If the sample is diluted, the diluted sample must be agitated in accordance with the instrument operating instructions to create a uniform dispersion of particles.

12.5 Pass the sample through the instrument for analysis.

12.6 Record the results.

13. Calculation

13.1 From the information provided, calculate the mean value and the percent above and below the specified sizes on the basis of weight, number, or volume.

14. Report

14.1 Report the mean particle size in micrometres, and the percent of the sample tested that is below and above certain specified values.

15. Precision and Bias

15.1 Because of the improbability of a single laboratory having all three types of particle size analyzers described in this test method, round-robin testing is not feasible. Also, since the three instruments measure different properties, complete agreement is not expected. However, for aliquots of a single sample of powdered ion exchange resin sent to owners of each type of instrument, the mean particle size values did not differ by more than 20 %.

⁸ Instruments from the following manufacturers have been found to be suitable. Instruments from other manufacturers may be suitable, but have not been evaluated: HIAC/ROYCO Division, Pacific Scientific, 141 Jefferson Dr., Menlo Park, CA 94025; Coulter Electronics, Industrial Div., 590 West 20 St., Hialeah, FL 33010; and Leeds & Northrup Co., Microtrac Div., 6950 Bryan Dairy Rd., Largo, FL 33547.

15.2 A statement of bias may not be obtainable for this test method, since different types of instruments are involved. More fundamentally, however, powdered resin particle size distribution measurements are statistical measurements on irregularly shaped particles, and an absolute, or true, value is not possible.

TEST METHOD B—SOLIDS CONTENT

16. Scope

16.1 This test method covers the determination of the percent solids in new powdered ion exchange resins. Both anion resin and cation resin may be tested by this test method. Resins are tested in the ionic form in which they are received.

16.2 It is important to note that ion exchange resins, particularly anion exchange resins in the hydroxide form, are subject to thermal degradation under the conditions of this test. Therefore, volatile degradation products are released along with moisture, resulting in a negative error. However, the value of this test method is that it is simple and reproducible, and it is applicable to as-received samples.

17. Summary of Test Method

17.1 This test method consists of determining the loss of mass on drying at $104 \pm 2^\circ\text{C}$ for 18 h.

18. Significance and Use

18.1 Powdered ion exchange resins are manufactured and shipped in a moist form. However, they are sold and used on a dry weight basis. Thus, it is important that the actual solids content of the resin be determined.

19. Sampling

19.1 Obtain a representative sample of the powdered ion exchange resin in accordance with Practices D 2687, Practice A, but substitute a 12.5-mm ($\frac{1}{2}$ -in.) inside diameter tube.

20. Procedure

20.1 Weigh three approximately 15-g representative samples of material to the nearest 1 mg into previously tared weighing vessels.

20.2 Heat the samples for 18 h at $104 \pm 2^\circ\text{C}$.

20.3 Remove the samples from the oven, cool at least 30 min in a desiccator to room temperature and reweigh.

21. Calculation

21.1 Calculate the solids content, in percent, as follows:

$$\text{Solids content, \%} = (B/A) \times 100$$

where:

A = wet sample used, g, and

B = dry sample obtained, g.

22. Report

22.1 Reject and repeat any sample analysis in which the result differs by more than 2 % from either of the other two samples.

22.2 Report the percent solids content as the average of the three values obtained.

23. Precision and Bias ⁹

23.1 The overall precision of this test method may be expressed as follows:

$$S_A = 1.43$$

$$S_C = 0.391$$

where:

S_A = overall precision for powdered anion exchange resins in hydroxide form expressed as weight percent solids, and

S_C = overall precision for powdered cation exchange resins in hydrogen or ammonium forms expressed as weight percent solids.

NOTE 1—Using this test method with resins in different ionic forms other than those indicated will, in general, increase the precision.

23.2 For the collaborative study, completed in 1982, eight powdered IEX resin samples were sent to eight laboratories. Two samples each of hydrogen form, ammonium form, hydroxide form and hydrogen/hydroxide mixed beds with fibers, were evaluated. The mixed sample results were not included in the precision calculations. Results of this collaborative study may not be typical of results for matrices other than those studied.

23.3 *Bias*—Ion Exchange resins are the product of a complex, multiple step synthesis involving a polymerization reaction followed by one or more additional reactions to put functional groups on the polymeric structure. Consequently, the true value for any property of the finished product is unknown and a bias statement cannot be given.

24. Keywords

24.1 floc; ion exchange; particle size; powdered resin; solids content

⁹ Supporting data for this test method has been filed at ASTM Headquarters. Request RR:D-19-1084.

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).