Designation: D7513 – 09

Standard Test Method for Capacity of Mixed Bed Ion Exchange Cartridges[1]

This standard is issued under the fixed designation D7513; 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 performance of mixed bed ion exchange resin cartridges in the active form when used for deionization. The test can be used to determine the initial capacity of unused cartridges or the remaining capacity of used cartridges. In this case performance is defined as ion exchange capacity (or throughput) to two defined endpoints. The method does not measure organics and does not attempt to determine the ultimate water quality attainable by the cartridge.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

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:*[2]

D1125 Test Methods for Electrical Conductivity and Resistivity of Water
D1129 Terminology Relating to Water
D1193 Specification for Reagent Water
D2777 Practice for Determination of Precision and Bias of Applicable Test Methods of Committee D19 on Water
D3375 Test Method for Column Capacity of Particulate Mixed Bed IonExchange Materials

3. Terminology

3.1 *Definitions*—For definitions of terms related to water, refer to Terminology D1129.

4. Summary of Test Method

4.1 This test method consists of exhausting a cartridge of mixed bed ion exchange material to a specific end point with an influent solution of known composition and volume.

5. Significance and Use

5.1 This test method can be used to evaluate unused mixed bed ion exchange cartridges for conformance to specifications.

5.2 This test method provides for the calculation of capacity in terms of the volume of water treated to a conductivity end point.

5.3 The test method as written assumes that the ion exchange resins in the cartridge are either partially or fully converted to the H^+ or OH^- form. Regeneration of the resins is not part of this method.

5.4 This test method provides for the calculation of capacity on a cartridge basis.

5.5 This test method may be used to test different size mixed bed resin cartridges. The flow rate of test water and the frequency of sampling are varied to compensate for the approximate volume of resin in the test cartridge.

6. Apparatus

6.1 *Test Assembly (Fig. 1)* , consisting of the following:

6.1.1 Cartridge, and pressure vessel, if required. Connections shall be provided at the top and the bottom for the admission and removal of the ion exchange test water as described in 7.3.

6.1.2 Test solution tank. Adequate means of regulating and measuring flow through the cartridge shall be provided. If the test flow rate (8.1) can not be obtained by gravity feed, then a pump should be used.

6.1.3 Measuring circuit and in-line conductivity cells shall be as described in Test Methods D1125. A continuous recorder is recommended.

7. Reagents and Materials

7.1 *Purity of Reagents*—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,

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[1] This test method is under the jurisdiction of ASTM Committee D19 on Water and is the direct responsibility of Subcommittee D19.08 on Membranes and Ion Exchange Materials.

Current edition approved March 15, 2009. Published April 2009. DOI: 10.1520/D7513-09.

[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.

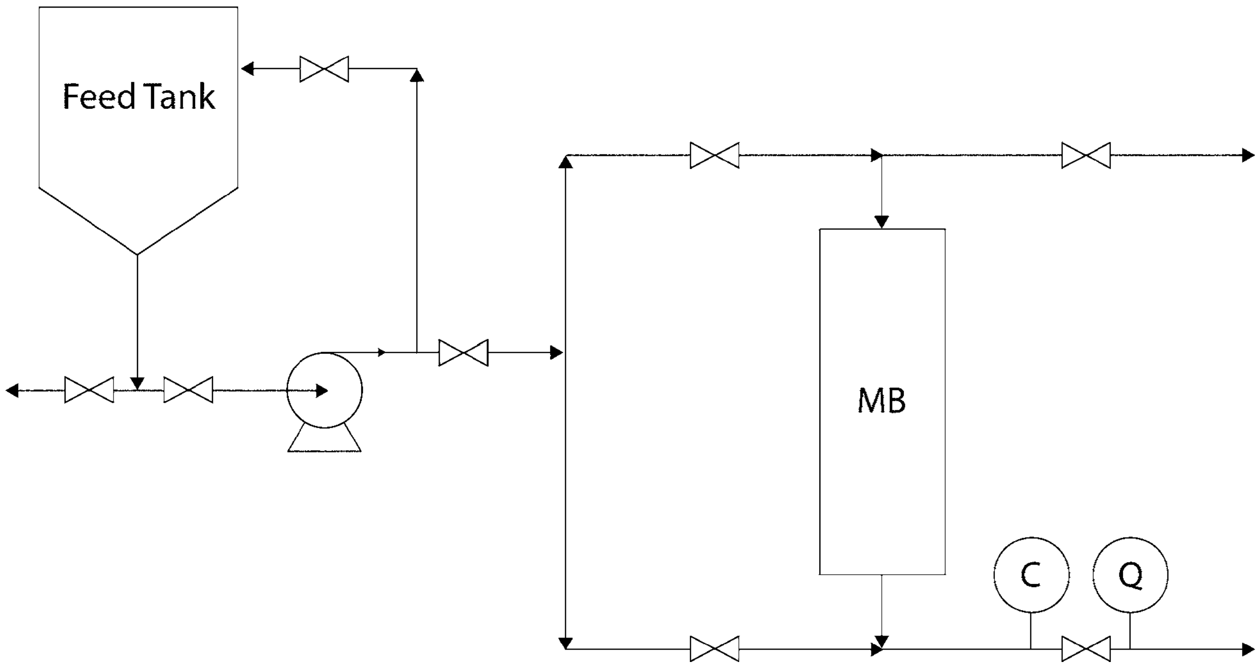

FIG. 1 Typical Apparatus for Performance Testing of Mixed-Bed Ion Exchange Cartridges

where such specifications are available.[3] 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.

7.2 *Purity of Water*—All reference to water in this test method shall be understood to mean Reagent Water Type I or II conforming to Specification D1193.

7.3 *Ion Exchange Test Water (10 meq/L, or 500 ppm as $CaCO_3$)*—Prepare a test water containing, in each litre:

7.3.1 0.294 g of calcium chloride dihydrate ($CaCl_2$-$2H_2O$),

7.3.2 0.336 g of oven-dried (105°C) sodium bicarbonate ($NaHCO_3$), and

7.3.3 0.120 g of oven-dried (105°C) anhydrous magnesium sulfate ($MgSO_4$).

7.4 A single test requires approximately 50 L of this solution for each litre of mixed bed ion exchange resin that a cartridge contains.

8. Procedure

8.1 Measure the outside diameter and length of the ion exchange cartridge. Calculate the overall cartridge volume (in litres) as follows:

$$V_c = \frac{\pi D^2 L}{(4)(1000)}$$

where:

D = the cartridge diameter, in cm

L = the cartridge length, in cm

8.2 Using the cartridge volume calculated in 8.1, calculate the test flow rate (in mL/min) as follows:

$$Q = 300V_c$$

where:

V_c = cartridge volume, in litres

NOTE 1—For multitube cartridges the volume is the sum of the volumes of all the tubes.

8.3 Slowly introduce reagent water at the bottom of the cartridge until the cartridge is full to expel air. Allow water to stand in the cartridge for 1–24 hours to "condition" the resin prior to the test.

8.4 Slowly introduce test water. Increase the flow rate Q to the value determined in 9.1, adjusting the rate as required with a valve or other flow restriction in the effluent line.

8.5 Measure and record the effluent conductivity each volumetric increment equal to 2 V_c. Continue until the 1.0 µS/cm value is reached, then record the volume of test water processed to a 1.0 µS/cm endpoint (V_1) in litres.

8.6 After reaching 1.0 µS/cm, take conductivity readings every 0.5 V_c until a reading greater than 50.0 µS/cm (<20 000 ohm-cm) is obtained.

8.7 Continue the readings every minute until two successive product conductivity readings exceed 50.0 µS/cm (20 000 ohm-cm). Stop the flow of test water and record the total test volume corresponding to the first of two successive 50.0 µS/cm readings as the total volume (V_T) of test water used, in litres.

9. Calculation

9.1 The operating capacity is calculated on a cartridge basis using a conductivity end point.

[3] *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 *Annual Standards for Laboratory Chemicals,* BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary,* U.S. Pharmacopeial Convention, Inc. (USPC), Rockville, MD.

9.2 Calculate the operating capacity to the conductivity end point as follows:

$$Capacity,\ meq/cartridge = C \times V_T$$

where:

C = concentration of total electrolytes in the test water expressed in milliequivalents per litre as described in 7.3, and
V_T = volume of test water used, per cartridge, litres.

This capacity may be converted to other measurement units as desired.

NOTE 2—Other end points may be agreed upon. When this is done the species and level selected should be specified with the results.

10. Report

10.1 The report of results of this test method should include not only the capacity as calculated above but the end point used. For certification purposes the averaging of results from three separate samples is customary.

11. Precision and Bias

11.1 The precision and bias for this method is expected to be the same as for Test Method D3375, upon which it is based. The collaborative study for Test Method D3375 involved six laboratories, six operators, and three replicate determinations on one material, IRN-150 mixed bed resin.

11.2 The single-operator precision, in a given laboratory, for this test method is equal to ±2.3 % of the column capacity expressed as milliequivalents per cartridge.

11.3 The precision of this test method, within its designated range, may be expressed as follows:

$$ST = 0.168 - 0.0208X$$

where:

S_T = overall precision in meq/mL, and
X = mixed bed cartridge capacity expressed as meq/mL for a conductivity end point.

11.4 Bias cannot be determined as in Test Method D3375 since known standards are not available.

12. Quality Control

12.1 In the analysis of ion exchange resins, it is not possible to prepare a known standard resin for comparison with the actual samples. Therefore it is impossible to test the accuracy of the results, and the method does not include a bias statement.

12.2 Analysts are expected to run replicate samples to determine if the results are within the expected precision stated in Section 11.

12.3 Analysis of the cartridge effluent is subject to the quality control requirements of the referenced analytical method.

13. Keywords

13.1 cartridge capacity; conductivity; ion exchange; mixed bed cartridge