Designation: C1814/C1814M – 20

Standard Test Method for Measurement of Hydraulic Characteristics of Stormwater Filtration Elements[1]

This standard is issued under the fixed designation C1814/C1814M; 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 standard shall be used to determine the hydraulic characteristics of stormwater filtration elements.

1.2 Elements tested shall be of a size commonly manufactured, not a scale model.

1.3 The position and orientation of all filter elements during testing shall be identical to the position and orientation used during normal operation.

1.4 The direction of flow during testing shall be identical to the direction of flow during normal operation.

1.5 As each stormwater treatment device is unique in design and hydraulic capacity, a sufficient number of accurately measured data points are needed to properly define the hydraulic characteristics of each test element. Therefore, it is imperative that the element setup and subsequent testing methodologies be well defined and executed to assure accurate flow and elevation data.

1.6 This test determines the hydraulic capacity of stormwater filtration systems. Test results are not an indicator of the filtration performance with respect to the capture of solids or other materials.

1.7 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

1.8 *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.*

1.9 *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]

D3858 Test Method for Open-Channel Flow Measurement of Water by Velocity-Area Method

D4409 Test Method for Velocity Measurements of Water in Open Channels with Rotating Element Current Meters

D5089 Test Method for Velocity Measurements of Water in Open Channels with Electromagnetic Current Meters

D5242 Test Method for Open-Channel Flow Measurement of Water with Thin-Plate Weirs

D5389 Test Method for Open-Channel Flow Measurement by Acoustic Velocity Meter Systems

D5413 Test Methods for Measurement of Water Levels in Open-Water Bodies

D5460 Test Method for Rubber Compounding Materials—Water in Rubber Additives

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

2.2 *ASME Standard:*

MFC-3M Measurement of Fluid Flow in Pipes Using Orifice, Nozzle, and Venturi[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *element*—the smallest filter unit that is commercially available or a combination thereof, or a full commercially available filter system comprised of one or more internal filter units.

[1] This test method is under the jurisdiction of ASTM Committee E64 on Stormwater Control Measures and is the direct responsibility of Subcommittee E64.01 on Lab 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.

[3] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, http://www.asme.org.

4. Summary of Test Method

4.1 This test method describes procedures and equipment required to measure the hydraulic characteristics of filtration elements (as defined in 3.1).

4.2 Other standards that may be useful to reference include: Test Methods D3858, D4409, D5089, D5242, D5389, D5413, Guide D5460, and ASME MFC-3M (see Section 2).

5. Significance and Use

5.1 Each element has unique flow patterns and each element has unique hydraulic characteristics (that is, flow and head loss). In addition, each element may exhibit variable hydraulic capacity as the element filters become occluded, the filter media swells or shrinks, and water viscosity (that is, water temperature) changes. In some cases filters experience hysteresis with respect to filling and emptying. The testing procedure in Section 7 will help develop the parameters necessary to determine the hydraulic capacity of an element at one instance in time. The test can be repeated at desired time increments to determine how the hydraulic capacity varies over time.

6. Apparatus

6.1 The test element shall be set up in the same configuration as a commercially available element. Pipe type, diameter, and orientation shall be configured such that they represent approach angles and velocities found in the field.[4] The selection of the approach or inlet velocity shall be such that the resulting flow capacity is the lowest for the range of possible velocities. The inlet and outlet pipe elevations also need to be hydraulically representative of that found in the field.

6.2 All components of the experimental setup shall be inspected immediately before all testing to confirm that no damage or obstruction is present and that there are no sediments or other deleterious materials therein. Leakage from the system piping or from the element shall not exceed 0.5 % of the measured flow rate.

7. Test Parameters and Methodologies

7.1 Several parameters shall be measured, recorded, and reported for use in establishing hydraulic capacity: the positive identification of the filter media, flow rate and direction through the filter, the surface area of the filter in a plane perpendicular to the flow, surface loading rate (flow per area), piezometric head upstream and downstream of the filter, the length of the filter in the direction of flow, and water temperature. When a test element consists of more than one filter units, the filter surface area and length of filter in the direction of flow shall be reported for both the individual filter units and for the element as a whole.

7.1.1 *Flow Rate Measurement*—The methodology for flow measurement includes the gravimetric method and open-channel and closed-conduit (full-pipe) flow meters. Suitable methods include, but are not restricted to, velocity area sensors, appropriate weirs and flumes, and pressure drop measurement methods using orifices, nozzles, or Venturi tubes.

7.1.2 *Piezometric Head*—Piezometric head shall be recorded for each flow rate The head measurement is taken from the static water surface elevation on the upstream side of the filter element, and at the invert of the discharge side of the filter element or appropriate piezometic head measurement at the outlet. Data collected shall record the depth of the upstream water surface elevation (WSE) relative to the dimensions of the filter such that it is clear when the filter element is partially exposed, submerged, and surcharged. The outlet measurement locations shall remain fixed for all flow conditions and serve as an elevation datum for all the various changes in the upstream WSE.

7.1.3 *Filter Length*—The length of the filter in the direction of flow shall be measured and reported. Filter lengths as provided by the device manufacturer are acceptable as long as they are validated prior to testing.

7.1.4 *Filter Surface Area*—The filter surface area in a plane perpendicular to the direction of flow at the point of first contact with the filter media shall be measured to the nearest 2 %. Surface areas of common geometric shapes (for example, rectangles, squares, circles, ovals, etc.) may be determined from measuring characteristic lengths (for example, length of sides, diameters, etc.) and calculating, by geometry, the corresponding surface area. When the filter area varies in the direction of flow, the reported filter area shall be that of the outermost media/water interface.

7.1.5 *Temperature*—Tests shall be run at a water temperature of 17 to 27°C [62-80°F].[5] At a minimum, water temperatures shall be recorded three times: at the beginning, the middle, and the end of each test. The average temperature shall be used in data reduction and reporting.

8. Filter Conditioning

8.1 Initial runs may exhibit different filter properties[6] as compared to subsequent runs. Thus, in order to more accurately represent filter characteristics, all filters must be conditioned prior to testing. Conditioning seeks to have these changes occur before testing begins. Actual conditioning procedures shall be reported.

8.2 Water levels upstream and downstream of the filter element shall be established such that the filter is completely submerged and the flow rate achieved is at least 90 % of the maximum flow rate to be tested. The flow rate shall be maintained at this level for at least two hours with flow rate measurements being made every 10 minutes at a minimum. After a minimum of two hours of continuous flow, the flow into the filter element shall be stopped and the filter allowed to drain to its natural static level. The filter element shall rest in this state with no additional inflow for 24 to 48 hours before testing begins.

[4] If the test cannot be run using the specified set up an alternative test set up may be used. In this case documentation shall be provided that states why the specified set up could not be used. The documentation shall also list all the ways that the test set up varies from the specified set up.

[5] The effect of temperature on viscosity is well known and can be significant over the given temperature range. Viscosity variations can potentially impact hydraulic characteristics.

[6] Filter properties may vary due to media compaction, the washing out of media fines, and media ripening, among others.

9. Procedure

9.1 All associated instrumentation shall be calibrated according to the manufacturer's specifications and verified before testing. Flow conditions shall be stabilized prior to commencement of testing. Flow conditions shall be considered stabilized when the upstream and downstream piezometric heads remain constant for at least five consecutive minutes. Piezometric heads shall be considered constant if they do not vary by more than ⅛ inch.[7]

9.2 *Manual Measurements*—Manual measurements of flow rate and of water pressure (piezometer water surface elevation), if used, shall be collected in accordance with 7.1 and as follows:

9.2.1 *Flow Rate Measurement*—When measuring the flow rate through an element, the flow rate entering the element shall be measured when the system is at steady-state. Steady-state is achieved when the upstream and downstream piezometric heads have stabilized as described in 9.2.2 and when four or more evenly spaced flow rate values have a coefficient of variation less than or equal to 0.03. All measured flow rates shall be within a window of ±5 % of the targeted flow rate and the coefficient of variation for these measured flow rates shall be less than or equal to 0.03.

9.2.1.1 For manual flow rate measurements, each flow rate data point shall consist of the average of three sets of measurements. Each set of measurements shall be taken at an interval of 5 minutes ± 30 s from the previous set. Each set of measurements shall consist of three discrete measurements taken in rapid succession with a maximum total measurement time of 60 s. The average of the nine discrete measurements collected in the three sets shall be recorded as the value for that data point.

9.2.1.2 If the readings are outside the acceptable tolerance, the flow shall be stabilized and the test repeated after the completed stabilization period.

9.2.1.3 After the flow rate has been determined, the piezometric heads upstream and downstream of the element shall be determined as in 9.2.2.

9.2.1.4 Flow rate measurements shall be taken at a minimum of ten approximately equal flow rate increments over the targeted flow rate range (for example, for a flow rate range of 25 to 250 gpm: 25, 50, 75....225, 250 gpm).

9.2.2 Piezometric head measurements shall be recorded upstream and downstream of the element as described in 7.1.2 using static water surface elevations or piezometric taps. The upstream and downstream piezometric head shall be considered stable when four or more evenly spaced measurements at the respective location have a coefficient of variation less than or equal to 0.03. Once the upstream and downstream piezometric heads have stabilized, the piezometric head at each location shall be determined from the average of three sets of measurements. Each set of measurements shall be taken at an interval of 1 minute ± 30 s from the previous set.

9.2.2.1 Each piezometric head data point shall consist of the average of three sets of measurements. Each set of measurements shall be taken at an interval of 1 minute ± 30 s from the previous set. Each set of measurements shall consist of three discrete measurements taken in rapid succession with a maximum total measurement time of 30 s. The average of the nine discrete measurements collected in the three sets shall be recorded as the value for that data point.

9.2.2.2 For each flow rate, the head loss across the element shall be determined as the difference in upstream and downstream piezometric head.

9.2.2.3 After the piezometric heads have been determined, the flow rate shall be adjusted and the process described in 9.2.1 and 9.2.2 shall be repeated, as necessary.

9.2.3 The water temperature shall be recorded at the beginning, middle, and end of the test run.

9.3 *Computerized Measurements*—Data recording using a computerized data acquisition (DA) system is preferred over manual measurements so that data are continuously recorded throughout the test, and the data have increased accuracy when coupled with calibrated flow meters and pressure transducers. At a minimum, flow and elevation measurements shall be averaged and recorded every 30 s throughout the duration of test. If the readings are outside the acceptable tolerance, the flow shall be stabilized and the test repeated after the completed stabilization period.

10. Report

10.1 A scaled diagram including a detailed description of the operation of the filter system and the flow meter type and location shall be included with the reported results. The description of the system shall include pipe diameters, lengths, types, and materials, as well as the actual test conditions: date, place, time, personnel, room conditions, etc. so that a complete description of the test conditions is presented.

10.2 The report shall provide a description of the media, with respect to opening size, media gradation and/or other properties which influence hydraulic conductivity as well as any filter conditioning requirements or attrition of filter media.

10.3 All water temperatures measured (under 7.1.5) shall be reported. If the tests are conducted outside the temperature range required under 7.1.5 (as may result from using flow from a natural water source), any correlated or corrected performance estimate shall reference in detail the source for such correlation or correction.

10.4 The report shall include a plot of the head loss (as defined in 9.2.2.2) across the element as a function of total flow rate through the element. The range of data collected and plotted shall be based on flow rate and shall span the range for which the element is designed, as provided by the manufacturer. At least ten approximately equally spaced data points shall be plotted over the required range of flow rates. The report shall also include, for the same range of flow rates, a plot of head loss across the element as a function of surface loading rate (that is, the specific flow rate), which is computed as the total flow rate divided by the total filter surface area as defined in 7.1.4.

[7] Calibration procedures for instrumentation used may vary depending on the measurement tool used and manufacturer recommendations. This is acceptable as long as measurements are assured with accuracy and tolerances stated in 7.1.1.