Designation: C1745/C1745M – 11

Standard Test Method for Measurement of Hydraulic Characteristics of Hydrodynamic Stormwater Separators and Underground Settling Devices[1]

This standard is issued under the fixed designation C1745/C1745M; 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 concerns measurement of selected hydraulic characteristics of hydrodynamic separators and underground settling devices critical to their function as stormwater treatment devices.

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

1.3 As each stormwater treatment device is unique in design, so are its hydraulic characteristics (flow versus head and loss coefficients). A sufficient number of accurately measured data points are needed to define properly the hydraulic characteristics of each test unit. Therefore, it is imperative that the unit setup and subsequent testing methodologies be well defined and executed to ensure accurate flow and elevation data.

1.4 This test method addresses gravity flow operation only. It does not address performance of units operating under pressurized conditions.

1.5 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 non-conformance with the standard.

1.6 *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]

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
D5640 Guide for Selection of Weirs and Flumes for Open-Channel Flow Measurement of Water

2.2 *ASME Standard:*[3]

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

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *inlet (or outlet) rounding, n*—radius of fillet at inside pipe junction with separator structure.

4. Summary of Test Method

4.1 This test method describes procedures and equipment required to measure the hydraulic characteristics of hydrodynamic separators and underground settling devices used for treating stormwater runoff.

4.2 Other standards that may be useful to reference include: Test Methods D3858, D4409, D5089, D5242, D5389, D5413, Guide D5640, and ASME MFC-3M (see Section 2).

5. Significance and Use

5.1 Each device has unique flow patterns and turbulence characteristics. In addition, each device exhibits a wide range of efficiencies as discharge, particle size, particle density, and flow viscosity (that is, water temperature) change. The testing procedure in Section 7 will help develop the parameters

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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, Three Park Ave., New York, NY 10016-5990, http://www.asme.org.

necessary to input into a function that describes the performance of a device under a wide range of application conditions.

6. Apparatus

6.1 The test unit shall be set up to reflect actual field installation parameters to the greatest degree possible. Influent and effluent pipes shall have a Manning's roughness coefficient not greater than 0.013 and shall be the minimum diameter recommended by the device manufacturer. Pipe type, diameter, slope (2 to 3 %), orientation, and inlet/outlet roundings shall be recorded and reported for each test. The influent pipe shall be a minimum of ten pipe diameters in length, or 6 m [20 ft] whichever is less, to ensure a uniform approach flow to the test unit, and an effluent pipe of length equivalent to three pipe diameters with a free-fall condition at its downstream end.

6.2 All components of the experimental setup shall be inspected immediately before any testing to confirm that no damage or obstruction is present and that there are no sediments or other deleterious materials therein. No leakage in system piping or from the unit is allowable during the test.

7. Test Parameters and Methodologies

7.1 Three major parameters shall be measured and recorded for use in establishing a unit's hydraulic characteristics: flow, water elevations, and water temperature.

7.1.1 *Water Elevation*—Pressure heads or water elevations shall be recorded for each condition tested to determine the head elevations. The locations of elevation measurements shall be fixed for all flow conditions. Elevation measurements shall be recorded in the influent and effluent pipes at locations 2 ± 0.1 pipe diameters upstream and downstream of the unit using piezometer taps in the pipe inverts. Internal measurements shall be recorded at a location that allows determination of bypass flow. Measurements are to be recorded using a data acquisition (DA) system and differential pressure (DP) cell or point-gage system adjusted to a known reference. Manual measurements using an engineer's ruler are acceptable for estimated elevations and shall be recorded as such.

NOTE 1—When supercritical flow occurs in the outlet pipe, the energy head at the outlet may appear to exceed the energy head at the inlet leading to erroneous determination of a loss coefficient. Under this condition, the critical depth at the outlet shall be determined and used for calculation of the unit loss coefficient.

7.1.2 *Flow Measurement*—The accuracy of the flow measurement shall be within ±2 % for controlled laboratory testing. The acceptable coefficient of variation of measurements is 0.03. 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.

7.1.3 *Temperature*—Tests shall be run at a water temperature of 18 to 20°C [64 to 68°F] (see Note 2). At a minimum, water temperatures in the sump of the test unit 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.

NOTE 2—Tests may be run outside of specified temperature range with a clearly stated deviation from the test method included in results (explicitly indicate temperatures as tested).

8. Procedure

8.1 All associated instrumentation shall be calibrated or verified or both to the manufacturer's specification before testing. Flow conditions shall be stable for a minimum of three system volume equivalents (residence time) before commencement of data collection.

NOTE 3—Calibration procedures for instrumentation used may vary depending on the measurement tool used and manufacturer recommendations. This is acceptable as long as measurements are ensured with accuracy and tolerances stated in 7.1.2.

8.2 *Manual Measurements*—Manual measurements of flow and of elevation shall be collected in accordance with 7.1.2 and reported as follows:

8.2.1 The system shall be at stabilized conditions of flow for a minimum of 5 min before measurement.

8.2.2 Each data point shall consist of the average of three sets of measurements.

8.2.3 Each set of measurements shall be taken at an interval of 5 min ± 30 s from the previous set.

8.2.4 Each set of measurements shall consist of three discrete measurements taken in rapid succession with a maximum total measurement time of 60 s.

8.2.5 The average of the nine discrete measurements collected in the three sets shall be recorded as the value for that data point.

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

8.3 *Computerized Measurements*—Data recording using a computerized 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 DP cells. 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.

9. Report

9.1 A scaled diagram including flow meter type and location shall be included with the reported results.

9.2 Head loss, as well as a loss coefficient (K) of the test unit, shall be reported by using the energy equation between upstream and downstream of the unit:

$$h_l = \left(h_u + \frac{V_u^2}{2g}\right) - \left(h_d + \frac{V_d^2}{2g}\right) \quad (1)$$

where:

h_l = device head loss,
h_u = measured pressure head or water elevation in the upstream pipe,

h_d = measured pressure head or water elevation in the downstream pipe,
g = gravitational constant, and
V_u and V_d = calculated average flow velocities in the upstream and downstream pipes at the tap locations, respectively.

9.2.1 Note that, according to 7.1.1, h_u and h_d are measured pressure heads or water elevations from the same datum.

10. Precision and Bias

10.1 The precision and bias of this test method will be available within five years.

11. Keywords

11.1 accuracy; bypass flow; calibration; flow; head loss; hydraulic capacity; orifice; slope; velocity; velocity head (head); weir