Designation: D1941 − 21

Standard Test Method for Open Channel Flow Measurement of Water with the Parshall Flume[1]

This standard is issued under the fixed designation D1941; 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 measurement of the volumetric flowrate of water and wastewater in open channels with the Parshall flume.

1.1.1 Information related to this test method can be found in ISO 1438 and ISO 4359.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered 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, 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]

D1129 Terminology Relating to Water

D2777 Practice for Determination of Precision and Bias of Applicable Test Methods of Committee D19 on Water

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

2.2 *ISO Standards:*[3]

ISO 555-2:1987 Liquid Flow Measurements in Open Channels—Dilution Methods for Measurement of Steady Flow—Constant Rate Injection Method

ISO 1438:2017 Liquid Flow Measurement in Open Channels Using Thin-Plate Weirs

ISO 4359:2013 Liquid Flow Measurement in Open Channels—Rectangular Trapezoidal and U-shaped Flumes

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this standard, refer to Terminology D1129.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *free flow, n*—a condition where the flowrate is governed by the state of flow at the crest overfall and hence can be determined from a single upstream depth measurement.

3.2.2 *head, n*—the height of a liquid above a specified point.

3.2.2.1 *Discussion*—That is, the flume crest.

3.2.3 *hydraulic jump, n*—an abrupt transition from supercritical to subcritical flow, accompanied by considerable turbulence or gravity waves, or both.

3.2.4 *normal depth, n*—the uniform depth of flow for a given flowrate in a long open channel of specific shape, roughness, and slope.

3.2.5 *primary instrument, n*—the device that creates a hydrodynamic condition that can be sensed by the secondary instrument.

3.2.5.1 *Discussion*—In this example, the primary instrument is the flume.

3.2.6 *scow float, n*—an in-stream flat for depth sensing that is usually mounted on a hinged cantilever.

3.2.7 *secondary instrument, n*—a device which measures the depth of flow at an appropriate location in the flume.

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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 D19.07 on Sediments, Geomorphology, and Open-Channel Flow.

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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 National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

3.2.7.1 *Discussion*—The secondary instrument may also convert the measured depth to an indicated flow rate.

3.2.8 *stilling well, n*—a small reservoir connected through a constricted passage to the main channel, that is, the flume, so that a depth measurement can be made under quiescent conditions.

3.2.9 *subcritical flow, n*—open channel flow at a velocity less than the velocity of gravity waves in the same depth of water.

3.2.9.1 *Discussion*—Subcritical flow is affected by downstream conditions, since disturbances are able to travel upstream.

3.2.10 *submerged flow, n*—a condition where the water stage downstream of the flume is sufficiently high to affect the flow over the flume crest and invalidates the free-flow depth-discharge relation.

3.2.10.1 *Discussion*—Under this condition, discharge depends on two head measurements.

3.2.11 *supercritical flow, n*—open channel flow at a velocity greater than that of gravity waves in the same depth, so disturbances cannot travel upstream, and downstream conditions do not affect the flow.

3.2.12 *throat, n*—the constriction in a flume.

4. Summary of Test Method

4.1 Parshall flumes are measuring flumes of specified geometries for which empirical relations of the form

$$Q = C\,H_a^{\,n} \tag{1}$$

have been established so that the flowrate, Q, can be determined from a single depth measurement, H_a, in free flow. If the flow is submerged, an addition downstream depth, H_b, must be measured and suitable adjustments made.

5. Significance and Use

5.1 Flume designs are available for throat sizes of 1 in. (2.54 cm) to 50 ft (15.2 m) which cover maximum flows of 0.2 to 3000 ft^3/s (0.0057 to 85 m^3/s) (**1**) and (**2**).[4] They can therefore be applied to a wide range of flows, with head losses that are moderate.

5.2 The flume is self-cleansing for moderate solids transport and therefore is suited for wastewater and flows with sediment.

6. Interferences

6.1 The flume is applicable only to open channel flow and is inoperative under full-pipe flow conditions.

6.2 Although the flume has substantial self-cleansing capacity, it can be clogged by debris or affected by accumulation of aquatic growth and cleaning or debris removal may be required.

7. Apparatus

7.1 A Parshall flume measuring system consists of the flume itself (primary) and a depth-measuring device (secondary). The secondary device can range from a simple scale for manual readings to an instrument which continuously senses the depth, converts it to flowrate, and provides a readout or record of instantaneous flowrate or totalized flow, or both.

7.2 *The Flume:*

7.2.1 Parshall flumes are characterized by throat width; dimensions and flowrates for each size are given in Fig. 1 and Table 1, respectively. The dimensions must be maintained within 2 %, because the flume is an empirical device and corrections for non-standard geometry are only estimates. The inside surface of the flume should be at least as smooth as a good quality concrete finish.

7.2.2 The measurement location for depth H_a is shown in Fig. 1. In submerged flow a second depth, H_b, must be measured in the throat as indicated. However, in the 1, 2, and 3-in. (2.54, 5.08, and 7.62-cm) flumes, this measurement is made at H_c instead, because disturbances have been observed at the H_b location in these sizes ((**1**) and (**2**)). See Fig. 2 for the relation between H_b and H_c.

7.3 *Stilling Well and Connector:*

7.3.1 Stilling wells are recommended for accurate depth measurements; they are required when wire- or tape-supported cylindrical floats are used or when the liquid surface is fluctuating.

7.3.2 The lateral area of the stilling well is governed in part by the requirements of the depth sensor. For example, the clearance between a float and the stilling-well wall should be at least 0.1 ft (3 cm) and should be increased to 0.25 ft (7.6 cm) if the well is made of concrete or other rough material, the float diameter itself being determined in part by permissible float lag error (see 12.4.2). Other types of depth sensors may also impose size requirements on the stilling well, and the maximum size may be limited by response lag.

7.3.3 Provision should be made for cleaning and flushing the stilling well to remove accumulated solids. It may be necessary to add a small purge flow of tap water to help keep

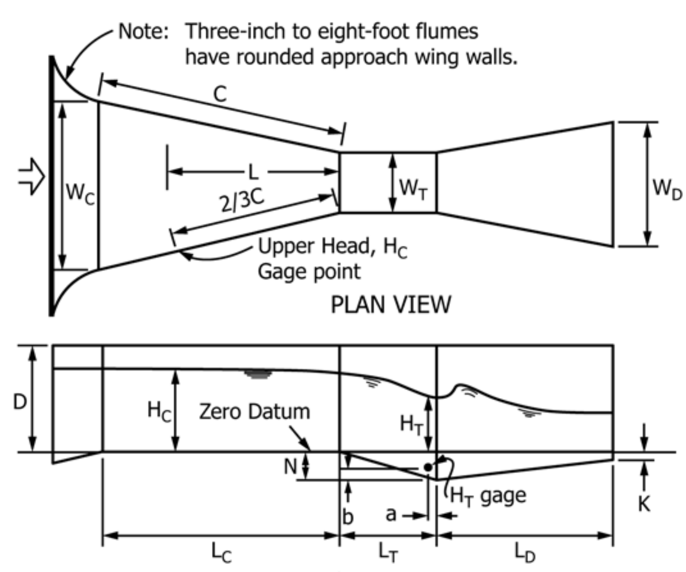

FIG. 1 Parshall Flume

[4] The boldface numbers in parentheses refer to a list of references at the end of this test method.