Designation: D2099 – 14

Standard Test Method for Dynamic Water Resistance of Shoe Upper Leather by the Maeser Water Penetration Tester[1]

This standard is issued under the fixed designation D2099; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This test method covers the determination of the dynamic water resistance of shoe upper leather by the Maeser water penetration tester. It is applicable to all types of shoe upper leather. Certain waterproof processes can cause contamination of the stainless steel balls. When this happens, visual inspection is recommended. This test method does not apply to wet blue.

1.2 Initial water penetration and water absorption can be measured by this test method.

1.3 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.

1.4 *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]

D1610 Practice for Conditioning Leather and Leather Products for Testing

D2098 Test Method for Dynamic Water Resistance of Shoe Upper Leather by the Dow Corning Leather Tester

D2813 Practice for Sampling Leather for Physical and Chemical Tests

3. Significance and Use

3.1 This test method is intended to estimate the water resistance of shoe upper leather. The flex imparted to the leather is similar to the flex given the vamp of the shoe in actual wear.

NOTE 1—There is an indication that this test method cannot be used interchangeably for specification purposes with Test Method D2098.

4. Apparatus

4.1 *Balance,* sensitive to 0.01 g.

4.2 *Maeser Water Penetration Tester,* as shown in Fig. 1, or its equivalent. The essential features of the machine are:

4.2.1 *Specimen Holder,* made of two V-shaped clamps with wedges for holding the specimen. The clamps shall be 2.5 ± 0.1 in. (63.5 ± 2.5 mm) apart, inside measurement, when their tops are in the same horizontal plane. One clamp shall be in a fixed position. The other clamp shall be pivoted as shown in Fig. 1 and attached, through a connecting link, to a motor-driven eccentric which turns at 90 ± 5 r/min. In one rotation of the eccentric, the center of the top of the movable clamp shall move a distance of 1 ± 0.05 in. (25.4 ± 1.3 mm) below the horizontal and return.

4.2.2 *Water Tank,* made of copper, stainless steel, or other noncorrosive material. It shall be of such a size that it can be placed around the clamps and of such a depth that, when in position for use, the top is 1.25 to 1.5 in. (31.7 to 38.1 mm) above the lowest point of the flexed clamp.

4.3 *Base for the Water Tank,* which is removable from between the machine frame and the water tank.

4.4 Two systems can be used to determine the number of cycles through which the specimen is flexed. One shall be a mechanical reset counter connected to the movable clamp. The other system shall be electrical and consist of a high and common electrode. The recommended resistance across the common electrodes is 50 000 Ω. When the resistance falls below this value, the relay will be energized. The high electrode shown is inside the leather specimen in contact with

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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.

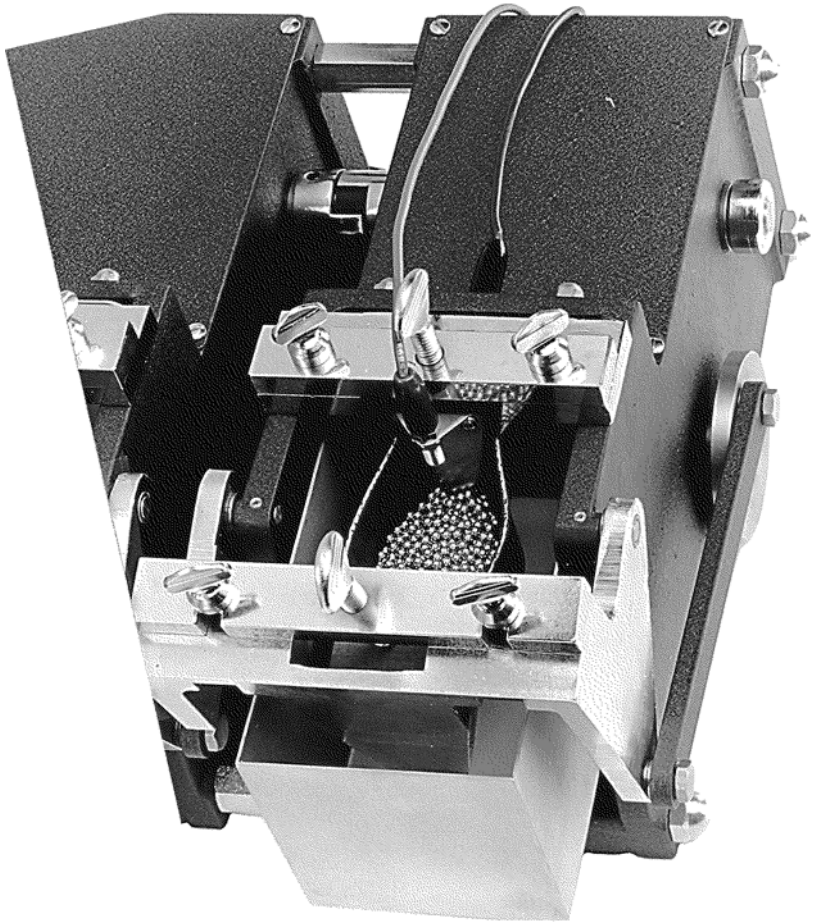

FIG. 1 Maeser Water Penetration Tester

FIG. 1 Maeser Water Penetration Tester *(continued)*

the steel balls. The common electrode is in a salt solution which is in continuous contact with the specimen during flexing.

4.5 Initial water penetration is detected by a current leakage from the high electrode through the specimen to the common electrode in the conducting solution. This causes a thyatron tube to fire, opening the relay and stopping the machine.

5. Reagents and Materials

5.1 *Magnet,* to facilitate removal of stainless steel balls.

5.2 *Magnetic Balls,* stainless steel, ⅛ in. (3 mm optional) in diameter, 400 series. The steel balls shall be clean and free of grease, oil, silicone, or rust, and have a resistance less than 7500 Ω before using. Steel balls need to be cleaned after each use.

5.2.1 To clean, immerse stainless steel balls in mild acid, 5 % Nitric. Rinse for 3 to 5 min under running tap water, and allow to air dry.

5.3 *Sodium Chloride Solution (1 g/L)*—Dissolve 1 g of sodium chloride (NaCl) in distilled water and dilute to 1 L. Solution shall be changed after each test.

6. Test Specimen

6.1 When taking test specimens from skins or hides refer to Practice D2813.

6.2 The test specimen shall be 4 by 4 ± 0.125 in. (101.6 by 101.6 ± 3.2 mm). The minimum size shall be 3⅞ by 4 in. (98.3 by 101.6 mm); the maximum shall be 4 by 4½ in. (101.6 by 114.3 mm).

6.2.1 Ensure flex in test is parallel to the backbone by pulling the cut edge that is parallel to the backbone in the clamp.

6.2.2 Prior to testing, the specimens shall be conditioned to Practice D1610.

7. Procedure

7.1 Determine the initial water penetration and water absorption on the same specimen, as follows:

7.1.1 Weigh the specimen to the nearest 0.01 g. Set the machine with the tops of the clamps in the same horizontal plane. Fold the specimen in half along the long dimension, with the surface to be exposed to the water on the outside. Fasten the specimen in the clamps by means of the V-shaped wedges, so that a trough is formed with the leather sides under slight tension. Construct the wedge assemblies from a nonconducting hard rubber and a laminated plastic as specified in Fig. 2.

7.1.2 Place 135 ± 5 g of stainless steel balls in the trough. (When automatic end point is not required, this step is eliminated.)

7.1.3 Put water tank in place and fill with NaCl solution to a level 0.75 ± 0.05 in. (19.1 ± 1.3 mm) above the lowest point of the specimen adjacent to the fixed clamp. Attach the other electrode to the pan, set the mechanical counter to zero, and activate the electrode circuit. It is not necessary to activate the electrode circuit if visual end point detection is desirable.

7.1.4 Turn on power to the mechanical drive.

7.1.5 To determine initial water penetration, record the number of flexes indicated on the mechanical counter at time of failure. When visual inspection is used, water penetration is easier to determine with the use of a light, for example, a flashlight, to brighten samples in the Maeser. When only one drop is present at a check, blot drop out and note number of flexes. Resume test and recheck in 5 to 10 min. If the drop returns, mark original flexes. If you see moisture or dark areas but no drops, use blue litmus paper to touch the dark area. If the paper changes color, mark down the flexes.

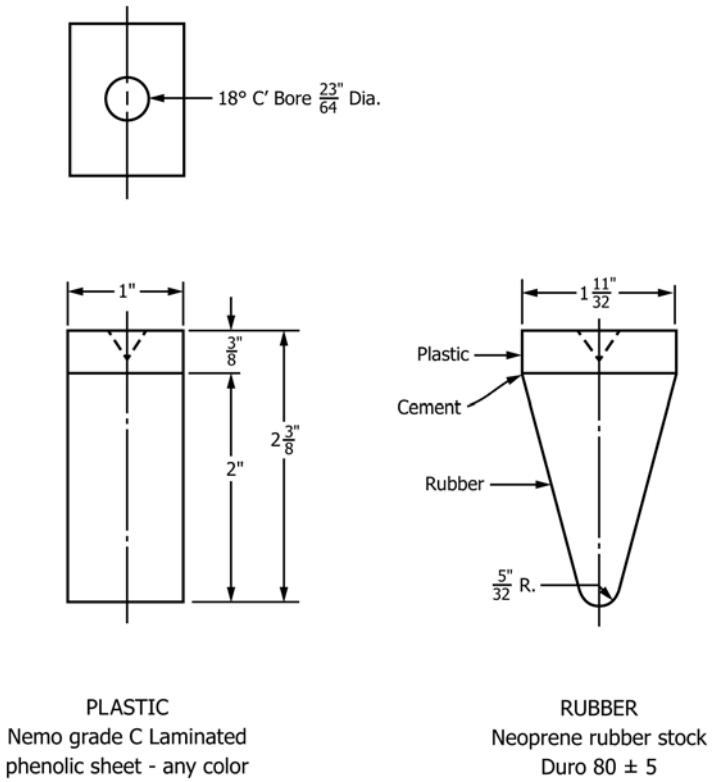

FIG. 2 Wedge Assemblies for Maeser Water Penetration Tester

7.1.6 To determine water absorption, remove the specimen from the machine, blot with absorbent paper, and weigh to the nearest 0.01 g.

8. Calculation

8.1 *Water Absorption*—Calculate the percentage water absorption as follows:

$$\text{Water absorption, } \% = [(A - B)/B] \times 100 \quad (1)$$

where:

A = mass of specimen after flexing and,
B = mass of specimen before flexing.

9. Report

9.1 Report the following information:

9.1.1 *Water Penetration:*

9.1.1.1 Number of flexes necessary to produce initial water penetration,

9.1.1.2 Method of penetration detection, visual or electronic,

9.1.1.3 Resistance setting of electronic shut off.

9.1.2 *Water Absorption:*

9.1.2.1 Percentage of water absorbed.

9.1.2.2 Number of cycles that specimens were flexed.

10. Precision and Bias

10.1 *Precision:*

10.1.1 *Initial Water Penetration:*

10.1.1.1 The shape of the distribution curve of the individual initial water penetration values is not normal due to extreme values. There is a tendency for the standard deviation of the average of the initial water penetration values to increase as the water resistance of the leather increases. Coefficients of variation of 100 % are not unusual.

10.1.1.2 Although the statistical analysis of initial water penetration data indicates poor quantitative precision, it is possible to rank leathers qualitatively in the order of their water resistance. Leather can also be judged on a pass/fail system based on a minimum acceptable level of flexes.

10.1.1.3 For research and development it is suggested that the bend, belly, and shoulder areas of at least 12 sides of a given treatment-leather combination be sampled in triplicate. After establishing the performance characteristics of a treatment on a given leather, the sampling need not be extensive for production control and specification acceptance.

10.1.1.4 Statistical analysis indicates that there is not a consistent correlation between electronic and visual detection methods. Leathers tested by these methods should be judged independently.

NOTE 2—The lack of correlation between the electronic and visual detection methods may be due to certain leather treatments, particularly oils and waxes. Leathers without these treatments show better correlation between the two detection methods.

10.1.2 *Water Absorption:*

10.1.2.1 The water absorption values tend to follow a more nearly normal distribution. Coefficients of variation of less than 25 % are not unusual.

10.1.2.2 When comparing water absorption values, it is recommended that all specimens receive the same number of flexes.

10.2 *Bias*—Since there is no accepted reference material suitable for determining the bias for this procedure, no statement on bias is being made.

11. Keywords

11.1 flexing; leather; water absorption; water penetration; water resistance