



Designation: D5117 – 17

# Standard Test Method for Dye Penetration of Solid Fiberglass Reinforced Pultruded Stock<sup>1</sup>

This standard is issued under the fixed designation D5117; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope\*

1.1 This dye-penetrant test method covers a means of evaluating solid fiberglass all-roving reinforced pultruded rod or bar stock for longitudinal wicking. There are generally three mechanisms that promote wicking such as delaminations, longitudinal continuous voids, or the presence of hollow fibers. Any or all of them will be operating at a given time.

NOTE 1—Occasionally the flaws listed above may be detected by this test, but other tests are usually required.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems has the potential to result in nonconformance with the 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.* For specific hazard statements, see 10.3 and 10.6.

NOTE 2—There is no known ISO equivalent to this test method.

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:<sup>2</sup>

[D618 Practice for Conditioning Plastics for Testing](#)

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.18 on Reinforced Thermosetting Plastics.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

[D883 Terminology Relating to Plastics](#)

[D3918 Terminology Relating to Reinforced Plastic Pultruded Products](#)

[E456 Terminology Relating to Quality and Statistics](#)

## 3. Terminology

3.1 *Definitions*—For definitions of technical terms pertaining to plastics used in this test method, see Terminology [D883](#).

3.2 For definitions of terms that appear in this standard relating to reinforced plastic pultruded products, refer to Terminology [D3918](#).

3.3 For definitions of terms that appear in this standard relating to quality and statistics, refer to Terminology [E456](#).

### 3.4 *Definitions of Terms Specific to This Standard:*

3.4.1 *wicking*—transmission of a gas or liquid due to pressure differential or capillary action along fibers incorporated in a fiberglass reinforced pultruded product.

## 4. Summary of Test Method

4.1 All-roving pultruded rod stock is tested by placing the specimen(s) on end into the dye penetrant to a specified depth and observing the wicking action as spots, or dots, on the opposite, dry face.

4.2 The wicking action through the length of the specimen is due to the capillary action of the penetrant through the open pathways in the composite. These pathways are typically occupied by air and are caused by continuous voids, cracks, or hollow fibers, or all three, simultaneously.

## 5. Significance and Use

5.1 This test method is useful for establishing the integrity of composite rod. The presence of voids, cracks, and hollow fibers are considered detrimental to the structural integrity of the composite and causes reduced electrical resistance and increased current leakage.

5.2 A perfect composite would be flaw-free, and there would be no possibility of wicking. Composites of this type are virtually nonexistent, as there will typically be entrapped air in the resin developed during manufacturing, occasional hollow fibers, and occasional cracks due to thermal stresses.

\*A Summary of Changes section appears at the end of this standard

5.3 This test method is intended to provide a tool for measuring the extent of wicking in a composite over very short lengths of material for comparative purposes. The presence of wicking over 1 in. (2.54 cm) lengths will not necessarily imply that the composite will perform unsatisfactorily for its intended end-use. Therefore, interpretation of test results shall be made carefully.

5.4 This test method was developed as a technique for estimating quality and consistency of pultruded rod and bar stock, which is a composite of resin and all-roving reinforcement. This test method will be useful for a manufacturer to determine whether any gross changes in quality have taken place due to process or raw material changes as the manufacturing process also affects the quality of the product.

5.5 Since the results of this test are so sensitive to sample size, penetrant type, penetrant used, viscosity, duration of test, and other factors, no attempt to arrive at or recommend development of a specification for these materials has been made. A specification shall be negotiated between supplier and end user and such specification shall be made with great care.

## 6. Apparatus

### 6.1 Dye Penetrant<sup>3</sup>

6.2 *Ultraviolet Light Source*—The penetrant used is fluorescent, and requires a black lamp light source.

6.3 *Dark Room*—An area for viewing the presence of fluorescent spots on the test specimens is required.

6.4 *Hood*—There is a need to provide adequate air ventilation for the elimination of any annoying vapors from the penetrant. These vapors are nontoxic, but has potential to be an irritant.

6.5 *Shallow Pan*, for holding the penetrant is required. A thin, spongy material that can be placed in the pan to support the specimen on one end.

6.6 *Stop Watch*, or other means for timing the length of the test is required.

6.7 *Magnifying Glass*, 5×, recommended for identifying very small fluorescent specks, or dots, on the specimen's upper face. It is not regarded as essential.

## 7. Materials

7.1 This test method was developed for use on solid pultruded all-roving rod and bar stock reinforced with fiberglass. An evaluation employed 1 in. diameter rod stock using epoxy, vinyl ester and polyester resins. It was determined that this test method is applicable for all three resin series.

7.2 Use rod-stock representative of typical production lots and select random specimens for testing.

## 8. Sampling and Test Specimens

8.1 Take at least three test specimens for each sample.

<sup>3</sup>Zyglo Penetrex ZL 30A dye penetrant, manufactured by Magnaflex, or equivalent, is suitable for this purpose. During the initial round-robin work, three standard penetrants of the industry were evaluated. The above referenced penetrant provided the most discriminating, rapid, and consistent results.

8.2 Specimens shall not be taken from material that has been damaged or subjected to previous testing.

8.3 Select at least three 1-in. (2.54 cm) length specimens taken at random locations along the rod stock to be tested. These shall be cut dry with a diamond-dust blade to ensure a smooth test surface.

8.4 In order to prevent the problem of wicking up the sides of some composites, paint a ring of clear nail polish or other suitable inhibitor below the top surface and around the circumference of each test specimen.

## 9. Conditioning

9.1 Condition the test specimens at  $23 \pm 2^\circ\text{C}$  ( $73.4 \pm 3.6^\circ\text{F}$ ) and  $50 \pm 10\%$  relative humidity for not less than 40 h prior to test in accordance with Procedure A of Practice D618.

9.2 *Test Conditions*—Conduct all testing in the standard laboratory atmosphere of  $23 \pm 2^\circ\text{C}$  ( $73.4 \pm 3.6^\circ\text{F}$ ) and  $50 \pm 10\%$  relative humidity, unless otherwise specified.

## 10. Procedure

10.1 Preheat the ultraviolet light source for 15 min or in accordance with the manufacturer's recommendations. Position the light to shine on the pan (penetrant) surface.

10.2 Place a thin, spongy material such as common household plastic foam sponge on the bottom of the pan to support the specimens. This material aids in properly wetting the bottom surface of the specimen and reduces possible problems associated with air entrapment.

10.3 Add sufficient dye to the pan such that the specimens will be immersed to a depth of  $\frac{1}{8}$  in. (0.32 cm) while resting on the sponge. This depth shall be predetermined with an extra piece of rod stock.

10.4 **Warning**—Avoid hand contact with the penetrant to preclude possible contamination of the specimens during handling. Wash hands thoroughly before proceeding, if contact with the penetrant were to occur.

Place each specimen on end in the penetrant to the depth specified in 10.3 and staggered from the rest of the group. The actual time of immersion for each shall be recorded if more than six specimens are to be tested at one time. Otherwise, all specimens shall be considered to be immersed at the same time. When more than six specimens are tested, an interval of 30 s between the respective immersions shall be observed. For example, if a group of nine specimens were to be tested, one could be added at  $T = 0$ , the next at  $T = 30$  s, and the last at  $T = 4.0$  min.

10.5 Immerse each specimen such that its lower face is inserted into the dye normal to the supporting sponge to ensure optimum coating of its surface. Press down lightly on the upper face of the specimen to effect its positive sealing.

10.6 See Warning in 10.4.

10.7 Position the specimens in the penetrant in a row left to right such that the first, second, etc. can be easily identified.

10.8 Record the time for the appearance of the first dot.