Designation: C581 – 15

An American National Standard

Standard Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass-Fiber-Reinforced Structures Intended for Liquid Service[1]

This standard is issued under the fixed designation C581; 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 practice is designed to evaluate, in an unstressed state, the chemical resistance of thermosetting resins used in the fabrication of reinforced thermosetting plastic (RTP) laminates. This practice provides for the determination of changes in the properties, described as follows, of the test specimens and test reagent after exposure of the specimens to the reagent: hardness of specimens, weight change thickness, appearance of specimens, appearance of immersion media, and flexural strength and modulus.

1.1.1 This practice is also useful to evaluate other factors, such as surfacing veils and the effect of resin additives, on the chemical resistance of the resin.

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.

NOTE 1—There is no known ISO equivalent to this 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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

D883 Terminology Relating to Plastics

D2563 Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts

D2583 Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor

D2584 Test Method for Ignition Loss of Cured Reinforced Resins

3. Terminology

3.1 *Definitions of Terms:*

3.1.1 For definitions of terms associated with plastic materials, see Terminology D883.

4. Significance and Use

4.1 The results obtained by this practice shall serve as a guide in, but not as the sole basis for, selection of a thermosetting resin used in an RTP structure. No attempt has been made to incorporate into the practice all the various factors that will potentially affect the serviceability of an RTP structure when subjected to chemical environments. These factors will potentially include stress, different resin-to-glass ratios, and multiple veils.

5. Apparatus

5.1 *Hardness Testing Instrument*—This shall be as described in Test Method D2583.

5.2 *Flexural Properties Testing Apparatus,* in accordance with Test Methods D790.

5.3 *Thickness Measurement*—A micrometer suitable for measurement to 0.001 in. (0.025 mm).

5.4 *Containers,* of sufficient size, capacity, and inertness to allow total immersion of reinforced thermosetting plastic specimens in the specific corrosives chosen for testing. These containers shall, when necessary, be capable of maintaining liquid levels of volatile solutions, that is, solvents. This can be accomplished by the use of reflux condensers.

5.5 *Heating Apparatus*—A constant temperature oven, heating mantle, or liquid bath capable of maintaining temperature

[1] This practice is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.23 on Reinforced Plastic Piping Systems and Chemical Equipment.

Current edition approved Dec. 1, 2015. Published January 2016. Originally approved in 1965. Last previous edition approved in 2008 as C581 – 03(2008)$^{\varepsilon 1}$. DOI: 10.1520/C0581-15.

[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.

within range of ±4.0°F (±2.2°C). Take proper precautions if the corrosives selected are flammable liquids.

5.6 *Analytical Balance,* suitable for accurate weighing to 0.001 g.

6. Reagents

6.1 The test media shall consist of the reagents or solutions to which the RTP laminates are to be exposed.

7. Test Specimens

7.1 *Standard Laminates*—Prepare standard fiber-reinforced laminates using identical reinforcement in all of the laminates. The laminates shall be constructed of the following materials:

7.1.1 *Surfacing Mat (Veil)*—A thin mat of fine fibers used primarily to produce a smooth, resin-rich surface on a reinforced plastic. The surfacing veil helps determine the thickness of the resin-rich layer, reduces microcracking and provides a non-wicking chemically–resistant layer. The surfacing veil shall be compatible with the resin, and manufactured with uniform fiber distribution and non-bundled fibers. The dry veil layer(s) shall be a minimum 10 mils in thickness and produce a 10 to 15 mil resin-saturated veil layer per 10 mils of dry veil. To eliminate the surfacing veil as a variable in corrosion tests, prepare each laminate within a test group with the same surfacing veil.

7.1.2 *Chopped Strand Mat*—Type E glass fiber with sizing and binder compatible with the resin. It is acceptable to use other glass fiber compositions, but using such alternate compositions shall be considered as variables for comparison to the standard.

7.1.2.1 Note that this practice applies to E-CR glass fiber, which is a type of E glass fiber. If the E glass fiber material is of the E-CR type that information shall be identified in the test report.

7.1.3 *Resin*—Catalyzed and promoted in accordance with the resin manufacturer's recommendation.

NOTE 2—It is acceptable to add fillers, such as antimony trioxide for improved fire performance or thixotropes for viscosity control, but it is possible that this will detract from the corrosion resistance of the test laminate.

7.2 *Dimensions and General Properties*—The laminates shall conform to the required dimensions and general properties of 7.2 and be fabricated in accordance with 7.3.

7.2.1 *Laminate Size*—A suitable laminate size has been found to be 26 by 33 in. (660 by 838 mm) after trimming. This laminate size is not restrictive and other dimensions are acceptable.

7.2.2 *Thickness*—The thickness of the cured standard laminate shall be between 0.120 and 0.140 in. (3.05 and 3.56 mm).

7.2.3 *Reinforcement Content*—The glass fiber and binder shall be 4.73 ± 0.47 oz/ft^2 (three layers of 1.5 oz/ft^2 chopped strand mat 4.5 oz/ft^2 having a nominal binder content of 3.5 % and two layers of 10 mil surfacing mat 0.23 oz/ft^2 having a nominal binder content of 7 %)—determined by preweighing the materials prior to construction of the laminate. This is equivalent to 23.6 weight % (12.5 volume %) glass fiber when using a resin having a cured specific gravity of 1.15. Such a laminate will have a thickness of 0.125 in. (3.18 mm). The use of resins having different specific gravities will result in different weight percentages of glass fiber, but the volume percentage of glass fiber will remain the same. When using synthetic organic fiber surfacing veil, the glass content shall be 4.50 ± 0.45 oz/ft^2 (three layers of 1.5oz/ft^2 chopped strand mat having a nominal binder content of 3.5 %).

7.2.4 *Hardness*—The hardness shall be at least 90 % of that of a fully-cured clear casting of the resin, or of a similarly constructed laminate as defined by the resin manufacturer. Hardness shall be determined in accordance with s5.1. Note that the use of synthetic veil will result in significantly lower hardness values. The hardness value will vary with the type of resin and number of plies of synthetic veil. The resin manufacturer needs to be contacted for the allowable Barcol hardness value of a laminate containing synthetic veils with the specific resin.

7.2.5 *Laminate Condition*—The laminate shall meet Acceptance Level I of Table I of Practice D2563.

7.3 *Fabrication of Standard Laminate*—The sequence of lay-up shall be as follows:

7.3.1 Apply catalyzed resin and a 10-mil (0.25-mm) surfacing mat on a flat surface covered with plastic release film or treated with a suitable release agent and roll to distribute resin.

NOTE 3—Use the following formula as a guide to determine the total weight of resin to be used. This is equivalent to 12.5 volume % glass fiber in the laminate. Grams resin equals grams glass fiber material per 7.2.3 times 2.82 *G*. Where *G* equals specific gravity of cured resin. It is acceptable to use excess resin due to loss by adhering to mixing containers, rollers, and other factors. A suggested amount of excess resin is 10 to 15 % by weight.

7.3.2 Follow with three plies of 1.5 oz/ft^2 chopped strand mat and resin. Roll after each ply to distribute and wet-out the chopped strand mat. Rolling with a serrated roller is acceptable after each ply to remove entrapped air but it shall be done in accordance with 7.3.4. The mat weight shall be within ±5 % of 1.5 oz/ft^2 upon weighing the full 26 by 33-in. cut (660 by 838-mm) piece, (or other full dimension used, 7.2.1.).

NOTE 4—Cut chopped strand mat so that the 26-in. dimension is across the width of the roll and the 33-in. dimension is along the machine direction of the mat. Mat weight variation will most commonly occur across the width of the mat. If a wide roll of mat, 52 in. (1320 mm) or greater, is used, place the two plies of mat in the laminate such that the center cut of one ply is placed over the outside edge of the second ply. If narrower width mat is used, reverse the second ply 180° in the machine direction and lay it on top of the first ply to minimize weight variations.

7.3.3 Follow with a 10-mil (0.25-mm) surfacing mat as in 7.3.1.

7.3.4 Remove the air by rolling over the surface with a serrated metal or plastic roller. Take care not to expel enough resin to raise the glass content above the permissible maximum. The laminate is considered within the range of allowable levels of resin and glass if the thickness of the laminate is within 0.120 and 0.140 in. (3.05 and 3.56 mm), as described in 7.2.2.

7.3.5 After the lay-up is completed, cover the laminate with a plastic release film to prevent air inhibition or to provide a uniform smooth glossy surface, or both. Carefully smooth down to remove entrapped air.