Designation: C 581 – 03

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 C 581; 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 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.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values in parentheses are given for information only.

NOTE 1—This practice may also be used to evaluate other factors, such as surfacing veils, the effect of resin additives, and fabrication variables on the chemical resistance of the resin.

NOTE 2—There is no similar or equivalent ISO 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:*

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials[2]

D 2563 Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts[3]

D 2583 Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor[3]

D 2584 Test Method for Ignition Loss of Cured Reinforced Resins[3]

3. Significance and Use

3.1 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 may enter into the serviceability of an RTP structure when subjected to chemical environments. These factors may include stress, different resin-to-glass ratios, and multiple veils.

4. Apparatus

4.1 *Hardness Testing Instrument*—This shall be as described in Test Method D 2583.

4.2 *Flexural Properties Testing Apparatus*, in accordance with Test Methods D 790.

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

4.4 *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.

4.5 *Heating Apparatus*—A constant temperature oven, heating mantle, or liquid bath capable of maintaining temperature within range of ±4.0°F (±2.2°C). Proper precautions should be taken if the corrosives selected are flammable liquids.

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

[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.

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[2] *Annual Book of ASTM Standards*, Vol 08.01.

[3] *Annual Book of ASTM Standards*, Vol 08.02.

5. Reagents

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

6. Test Specimens

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

6.1.1 *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.

6.1.2 *Chopped Strand Mat*—Type E glass fiber with sizing and binder compatible with the resin. Other glass fiber compositions may be used but should be considered as variables for comparison to the standard.

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

NOTE 3—Fillers, such as antimony trioxide for improved fire retardancy or thixotropes for viscosity control, may be added, but may detract from the corrosion resistance of the test laminate.

6.2 *Dimensions and General Properties*—The laminates shall conform to the required dimensions and general properties of 6.2 and be fabricated in accordance with 6.3.

6.2.1 *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 may be used.

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

6.2.3 *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 %).

6.2.4 *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 s4.1. It should be noted 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 should be contacted for the allowable Barcol hardness value of a laminate containing synthetic veils with the specific resin.

6.2.5 *Laminate Condition*—The laminate shall meet Acceptance Level I of Table I of Practice D 2563.

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

6.3.1 Apply catalyzed resin and a 10-mil (0.25-mm) surfacing mat on a flat surface covered with plastic release film[4] or treated with a suitable release agent and roll to distribute resin.

NOTE 4—The following formula may be used 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 6.2.3 times 2.82 *G*. Where *G* equals specific gravity of cured resin. Excess resin may be used due to loss by adhering to mixing containers, rollers, and other factors. A suggested amount of excess resin is 10 to 15 % by weight.

6.3.2 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 may be done after each ply to remove entrapped air but shall be done in accordance with 6.3.4. 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, 6.2.1.).

NOTE 5—Chopped strand mat should be cut 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, the two plies of mat should be placed 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, the second ply should be reversed 180° in the machine direction and laid on top of the first ply to minimize weight variations.

6.3.3 Follow with a 10-mil (0.25-mm) surfacing mat as in 6.3.1.

6.3.4 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 6.2.2.

6.3.5 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.

NOTE 6—The application of the release film may be accomplished by any convenient method. Regardless of how it is applied, it is critical that any entrapped air between the film and the laminate be entirely removed. One method of application is done by previously wrapping the film around a metal rod. Starting at one edge of the laminate, slowly unroll the film from the rod, keeping a bead of resin ahead of the rod as you cross the laminate. Any entrapped air remaining can be removed by rubbing a tongue depressor across the release film surface. Carefully pull the film

[4] 3 to 5 mil standard oriented polyester film (MYLAR®—Types A, S, or D, or MELINEX®—Types S, 0, or 442) has been found suitable for this purpose.