Designation: D4398 – 07

AnAmerican National Standard

Standard Test Method for Determining the Chemical Resistance of Fiberglass-Reinforced Thermosetting Resins by One-Side Panel Exposure[1]

This standard is issued under the fixed designation D4398; 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 is intended for use in the evaluation of the chemical resistance of fiberglass-reinforced thermosetting resins that are subjected to one-side panel exposure to specific environments. It takes into consideration the coldwall effects and radiation losses of heat transfer through the laminate wall.

1.2 This test method is supplemental to Practice C581 and does not supersede it.

NOTE 1—There is no known ISO equivalent to this standard.

1.3 *This standard does not purport to address all of the safety problems, 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]

C581 Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass-Fiber-Reinforced Structures Intended for Liquid Service

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

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

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *glass fiber*—glass filaments for engineering applications, most commonly "E" type made from a lime-alumina borosilicate glass that is relatively soda free, of high strength-to-weight ratio with a sizing compatible with the resin being used. Other glass fiber compositions may be used but should be considered as variables for comparison to the standard. Glass fibers are used commercially in the reinforcement of rigid engineering plastic structures.

3.1.2 *thermosetting resins*—linear, relatively low molecular weight polymer chains that react during cure forming "cross-links" which bond the chains together with primary valence bonds. Once cross-linked, such three-dimensional polymers will not soften appreciably up to their decomposition temperature. Typical of such resin systems are the polymers, vinyl esters, and epoxies.

4. Significance and Use

4.1 The results obtained by this test method may serve as a guide in, but not as the sole basis for, predicting the possible performance of the particular glass-fiber-reinforced thermosetting resin laminate in the one-side exposure to the specific environment under evaluation. No attempt has been made to incorporate into the test method all of the factors that may enter into the serviceability of a glass-fiber-reinforced resin structure when subjected to chemical environments.

4.2 This test method provides for the determination of changes in the physical properties of the test panel and test media during and after the one-side exposure in the test media. Determination of changes include: Barcol hardness, appearance of panel, appearance of test media, flexural properties, and thickness.

5. Apparatus

5.1 *Test Cell*—This is a laboratory unit in which only the surface of one side of a test panel is subjected to the corrosive or aggressive environment, which is the normal experience of chemical processing equipment in actual plant operations. It consists of an open-ended glass cylinder, with several ground-glass joint nozzles for insertion of appropriate auxiliaries. The ends of the open glass cylinder are closed off with the fiberglass-reinforced resin panel to be tested, and are tightly sealed with chemical-resistant gaskets, allowing one side of the panel to come in contact with the test media.

[1] This test method 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] 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.

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

5.1.1 Typical test cells are shown in Fig. 1 and Fig. 2. Other laboratory units for one-side corrosion testing of equal or larger diameter may be used also with correspondingly appropriate panel sizes.

5.2 *Reflux Condenser*—To maintain a constant liquid level and constant concentration of the test media.

5.3 *Electrical Heating Mantle*—Wrapped on the exterior to supply heat through the glass cylinder into the liquid, but not touching the test panel. An alternative source of heat can be provided by an electrical heating element encased in a suitable glass probe.

5.4 *Thermometer*—To register the temperature of the test media under test, as well as that of the vapor phase above the liquid.

5.5 *Rheostat Power Source*—A variable resistance for regulating current flow and capable of maintaining the temperature within a range of ±4°F (±2.2°C).

5.6 *Impressor Type Instruments*—As described in Test Method D2583.

5.7 *Micrometer*—Instrument suitable for measurement to 0.001 in. (0.025 mm).

5.8 *Flexural Properties Testing*—This shall be in accordance with the testing machine described in Test Methods D790.

6. Test Specimens

6.1 The fiberglass-reinforced thermosetting resin laminate panels prepared in accordance with Practice C581, or composites conforming to the construction used in fabrication of that specific structure, may be employed for testing.

6.2 Test panels shall be of appropriate dimensions to provide sufficient surface area to seal the open ends of the test cell, as well as to provide sufficiently exposed surface to enable coupons to be cut from it for determination of physical properties. As an example, Fig. 3 shows such pertinent dimensional data for the panels used with the Corrocell. If test panels are used with larger-diameter test units, the mounting arrangement may be adjusted accordingly, or C-clamps may be used.

7. Test Environment and Conditioning

7.1 The test media shall consist of the reagents, solutions, slurries, gases, or products that actually constitute the specific environment to which the fiberglass-reinforced thermosetting resin system will be exposed.

7.2 The standard reagents for basic evaluation of resin-glass systems, as detailed in the Appendix of Practice C581, can serve as test solutions when comparing the relative corrosion resistance of specific fiberglass-reinforced resin laminates.

7.3 The test media and conditioning shall simulate the anticipated service conditions as closely as possible.

7.4 Mechanical agitation, or mixing through aeration, may be employed to eliminate stratification of liquids, or to prevent sedimentation or settling out of the slurry.

8. Procedure

8.1 *Measurement of Panels*—Measure the thickness of the test panels to the nearest 0.001 in. (0.025 mm) at the geometric

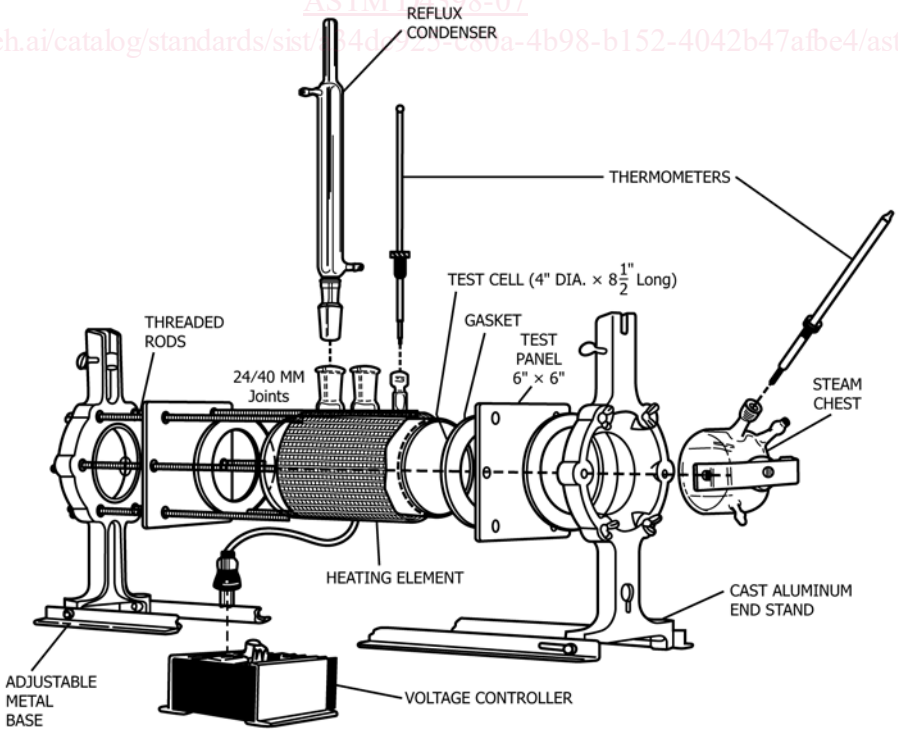

FIG. 1 Test Cells

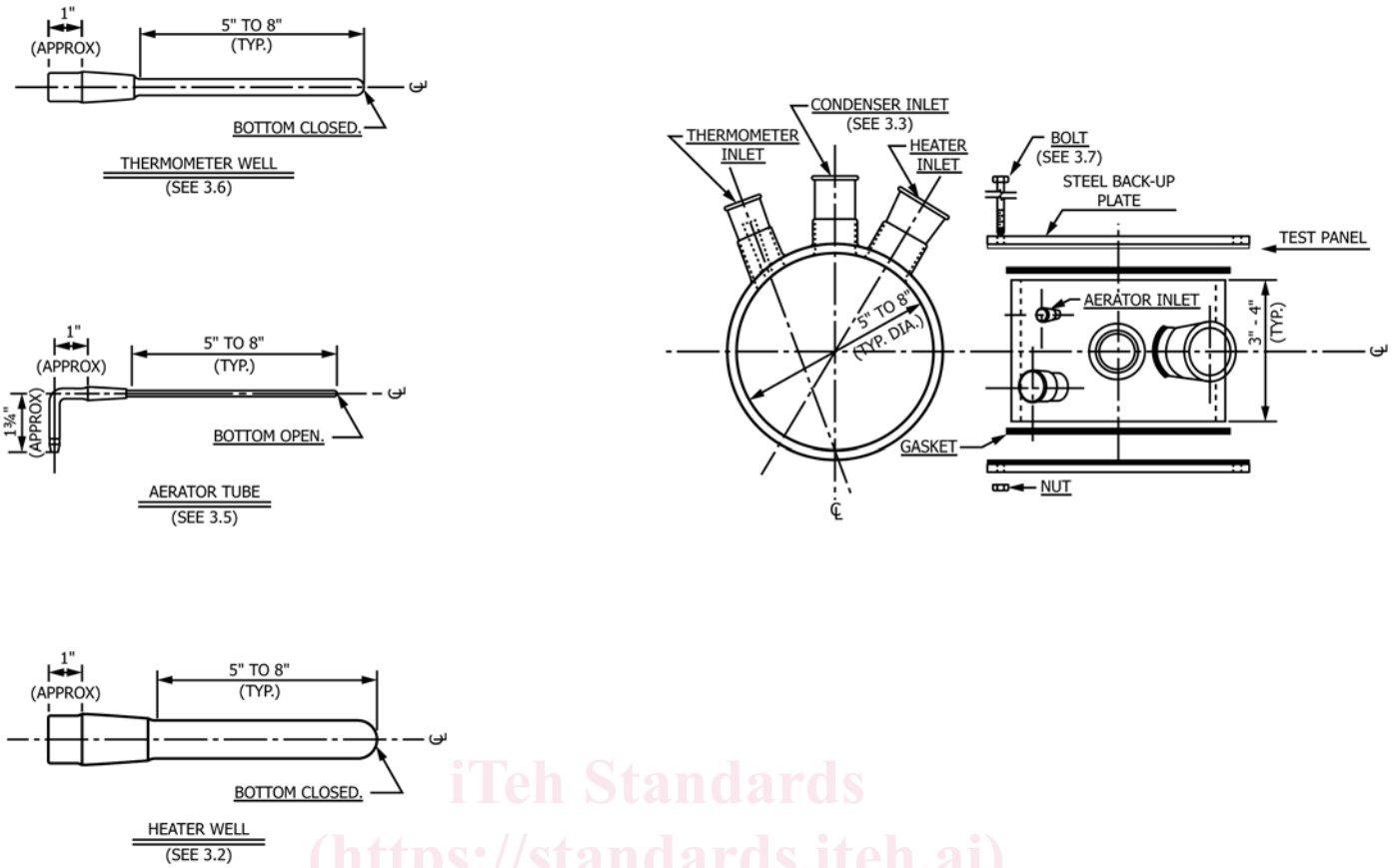

FIG. 2 Test Cells

center of the panel and 1.50 in. (38.1 mm) directly above and below that center point, for reference points in the later determination of any thickness changes.

8.2 *Preliminary Inspection of Panels*—Prior to affixing the panels to the test cylinder, record a brief description of the color and surface appearance of the panels. Make ten readings of the Barcol hardness around the periphery of the square panel at a distance no greater than 0.75 in. (19 mm) from the edge, recording the individual values. Do not take any Barcol hardness readings within the inner portion of the test panel that will be exposed to the specific test media. Record the color and clarity of the test media prior to exposure of the panels. Save a portion of the initial test media for future comparison with the exposed test media on completion of the test period. Retain a section of the original unexposed panel for use in evaluating any apparent changes to the exposed panel.

8.3 *Operation:*

8.3.1 Place the panels on the ends of the test cell and fill the vessel with the test media until it has reached the geometric center of the panels. Elevate the temperature of the test media to the desired operating temperature while maintaining the ambient air at a temperature of 23 ±2 °C (73.4 ± 3.6°F) and a relative humidity of 50 ± 5%. Other ambient conditions may be used and included in the report. Make certain that the reflux condenser is performing properly to maintain constant volume in the cell. Discard the test solution and replace it with fresh solution as often as necessary to maintain original composition and concentration. As a minimum, solutions known to be stable should be replaced at the end of each test period.

8.3.1.1 As an alternate, the configuration of the vessel can be vertical with the panel at one end exposed to liquid and the panel at the other end exposed to vapor. This test method will require more test vessels, but will eliminate the need for a reflux condenser unless it is needed to minimize vapor loss that will result in a change in the composition of the test media. Maintain the liquid level within the middle one third of the distance between the panels.

8.3.2 Examine the surfaces of the panels as desired after 30, 60, 90, 180 days, and after 1 year of exposure, or at any other interval of exposure, as indicated by their performance. Record any changes in surface appearance of panels and changes in the test media. Terminate the test if the panels show excessive chemical attack.

NOTE 2—Although one test cell can be employed to complete the 30, 60, 90, 180 days, and 1 year (360 days) exposure study, generally two test cells are used for duplicate or comparative testing and expediency. The panel replacement procedure commonly scheduled in the use of two test cells follows along those suggested in 8.3.3.

8.3.3 Typical panel exposure schedule:

	Cell 1		Cell 2	
	Side One	Side Two	Side One	Side Two
Initial setup	30 days	360 days	30 days	360 days
Replacement 1	60 days	None	60 days	None
Replacement 2	90 days	None	90 days	None
Replacement 3	180 days	None	180 days	None