Designation: D 3982 – 98

An American National Standard

Standard Specification for Contact Molded "Fiberglass" (Glass Fiber Reinforced Thermosetting Resin) Duct and Hoods[1]

This standard is issued under the fixed designation D 3982; 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 specification covers ducts and hoods fabricated by contact molding intended for use in handling corrosive fumes and process gases. Special attention is given to equipment that operates at temperatures over 180°F (82.2°C) with regard to strength and corrosion resistance.

1.2 The material of construction shall be "fiberglass" consisting of a polyester, vinyl ester, or other qualified resin-matrix systems with fiber reinforcement in accordance with Specification C 582.

1.3 This specification is not intended to cover selection of resins and reinforcements for specific chemical environments.

1.4 All descriptions and limitations in this specification are to include both ducts and hoods, where applicable.

1.5 This specification covers ducts and hoods up to a design pressure of ±5 psig (34.5 Pa).

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

2. Referenced Documents

2.1 *ASTM Standards:*

C 581 Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass Fiber Reinforced Structures, Intended for Liquid Service[2]

C 582 Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion Resistant Equipment[2]

D 883 Terminology Relating to Plastics[3]

D 2583 Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor[4]

D 2584 Test Method for Ignition Loss of Cured Reinforced Resins[4]

F 412 Terminology Relating to Plastic Piping Systems[2]

F 436 Specification for Hardened Steel Washers[5]

2.2 *NFPA Standard:*

NFPA 91 Installation of Blower and Exhaust Systems for Duct, Stack and Vapor Removal or Conveying[6]

3. Terminology

3.1 *Definitions:*

3.1.1 The definitions used in this specification are in accordance with definitions in Terminologies D 883 and F 412, unless otherwise specified.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *calculated thickness*—this description is in accordance with the standard laminate composition tables for Types I and II in Specification C 582.

3.2.2 *contact molding*—includes the "hand layup" and the "spray up" methods of manufacture.

3.2.3 *flange cant*—the angle that an entire branch is off from being perpendicular to the main run centerline (see Fig. 1).

3.2.4 *flange flatness*—maximum deviation, (see Fig. 2) from the actual flange face not including warpage or perpendicularity.

3.2.5 *flange offset*—the amount that an entire branch is off the main run centerline (see Fig. 3).

3.2.6 *flange perpendicularity*—maximum angle that the plane (see Fig. 2) of the flange inside diameter makes with the perpendicular plane to the duct's centerline.

3.2.7 *flange warpage*—the amount that a flange outside diameter pulls back from the plane of the inside diameter during the cure of the material (see Fig. 2).

3.2.8 *hand layup*—application of glass plies in sheet form by hand. Resin can be applied by either brushing, rolling, or spraying.

3.2.9 *minimum thickness*—take six thickness readings. The average of the six readings shall be a minimum of 85 % of the calculated thickness. This must contain the required layers of glass.

3.2.10 *spray up*—fiberglass roving is chopped and blown onto the mold in conjunction with resin and catalyst.

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[1] This specification is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.23on Reinforced Plastic Piping Systems and Chemical Equipment.

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[2] *Annual Book of ASTM Standards*, Vol 08.04.

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

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

[5] *Annual Book of ASTM Standards*, Vol 15.08.

[6] Available from National Fire Protection Assn., 470 Atlantic Ave., Boston, MA 02210.

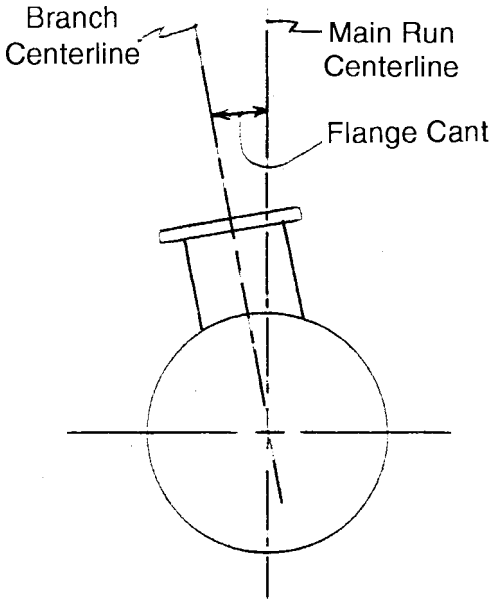

FIG. 1 Flange Cant

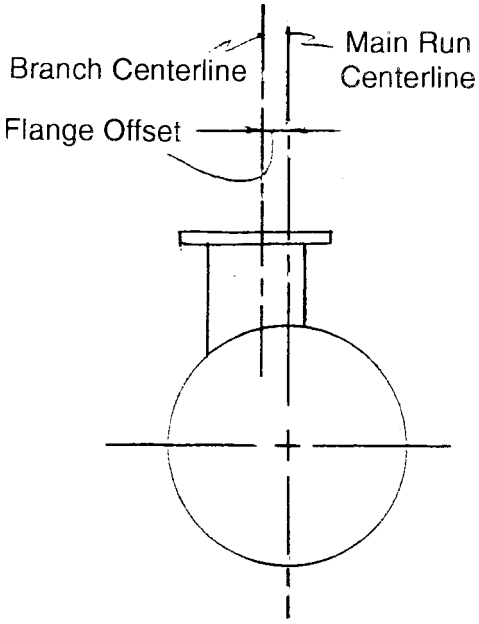

FIG. 3 Flange Offset

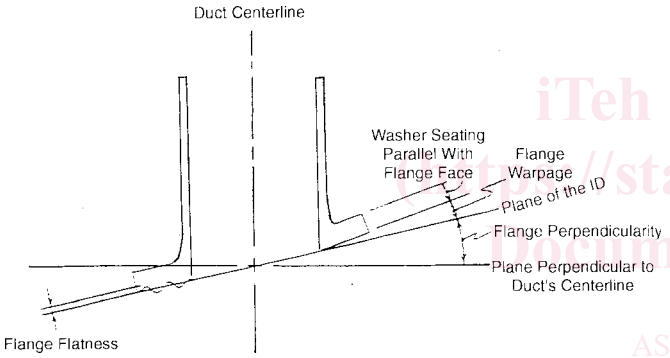

FIG. 2 Flange Tolerance Description

3.3 *Abbreviations:Symbols and Abbreviations:*

3.3.1 *M* = 1½ oz/ft^2 chopped-strand mat.

3.3.2 *R* = 24 oz/yd^2 woven-roving with a 5 by 4 weave.

3.3.3 *V* = glass or synthetic veil, 0.010 in. (0.25 mm) calculated thickness.

3.3.4 For additional symbols and abbreviations specific to design requirements, see 6.2.1.

4. Materials and Manufacture

4.1 *Resin*—The resin used shall be a commercial-grade thermoset that has either been evaluated in a laminate by test in accordance with Practice C 581 or that has been determined by previous documented service to be acceptable for service conditions. Where service conditions have not been evaluated a suitable resin may be selected by agreement between the manufacturer and the end user.

4.1.1 The resin may contain fillers or pigments in accordance with Specification C 582.

4.1.2 A thixotropic agent may be added up to 5 % by weight of resin.

NOTE 1—The addition of a thixotropic agent may reduce the resistance of many resin systems to certain corrosive chemical environments. It is the responsibility of the fabricator, using a thixotropic agent in the resin to ascertain its compatibility with the corrosive environment when this has been reported to him by the purchaser.

4.1.3 Fire-retardant additives may be added to resins if required to reduce flame spread.

NOTE 2—Because the addition of fire-retardant agents may interfere with visual inspection of laminate quality, they should not be used in the inner surface or interior layer unless their functional advantages would outweigh the loss of visual inspection.

4.1.4 Where static electricity has been determined to be a problem by the engineer, the inner surface of the ductwork shall be grounded with a maximum resistance to ground of 10^6 Ω. The grounding method shall be determined by the manufacturer and the purchaser.

4.2 *Reinforcement*—Glass reinforcing material with a binder and sizing compatible with the resin to be used. Fiber reinforcements shall be in accordance with and meet the requirements of Specification C 582 including composition requirements for Type I and Type II laminates.

4.2.1 *Corrosion Barrier*—Consists of the inner surface followed by the interior layer which has a minimum total calculated thickness of 0.096 in. (2.4 mm).

4.2.1.1 *Inner Surface*—Surfacing veil with approximately 90 % resin and 0.010 to 0.020-in. (0.25 to 0.50-mm) calculated thickness.

4.2.1.2 *Interior Layer*—A minimum of two plies of 1½ oz/ft^2 chopped-strand mat or chopped roving equivalent with a compatible sizing system with approximately 75 % resin and 0.086-in. (2.2-mm) calculated thickness minimum. Fiber length shall be ½ in. (12.7 mm) minimum to 2 in. (50.8 mm) maximum.

4.2.2 *Structural Layer*—Shall consist of chopped-strand mat plies of nominally 1½ oz/ft^2 and have a ½ in. (12.7 mm) minimum to 2 in. (50.8 mm) maximum fiber length, or shall consist of a chopped roving equivalent in the spray-up method. When necessary, woven-roving plies shall be used and shall consist of 24 oz/yd^2 with a five by four weave or a suitable

equivalent agreed on by the end user and the fabricator. Woven-roving shall be applied alternately with a minimum of a 1½ oz/yd ^{2} mat or chopped roving equivalent, finishing with a mat layer.

4.2.3 *Outer Surface*—Shall be coated with a resin-rich layer and containing 0.2 to 0.6 % paraffin wax with a melting point of 122 to 126°F (50.0 to 52.2°C), except when not required as determined by the engineer.

5. Physical Properties

5.1 Minimum wall of (*V, M, M, M*) shall be maintained under any circumstances.

5.2 Laminates or portions of laminates comprised only of chopped-strand mat shall have a 25 to 30 % glass content by weight when tested by Test Method D 2584.

5.3 Minimum mechanical properties of standard laminates shall be in accordance with Specification C 582.

6. Design Requirements

6.1 *Design Limitations*:

6.1.1 *Safety Factor*—Use five for external pressure, use ten for internal pressure and all other design calculations.

6.1.2 *Maximum Permissible Deflection Under Design Load*—Use 1 % of the span for laminates not exposed to a chemical environment and use ½ % of the span for allowable deflection when a chemical environment will be in contact with the laminate.

6.1.3 *Secondary Bond Strength*—When the load is along the surface, use 2000 psi (13.79 MPa) ultimate shear stress for the bonding surface area. Use a safety factor of ten when calculating allowable secondary bonding stresses.

6.1.4 When an extra corrosion barrier is specified, do not include this thickness in the design calculations.

6.1.5 Increase all calculated wall thicknesses to the nearest standard wall thickness. Treat these standard wall thicknesses as minimum dimensions.

6.2 *Cylinder Wall Design*:

6.2.1 *Symbols and Abbreviations*:

6.2.1.1 *P*—Actual design pressure, psi (MPa).

6.2.1.2 *PA*—Allowable pressure, psi (MPa).

6.2.1.3 D_o—Outside diameter of cylinder, in. (mm).

6.2.1.4 *D*—Inside diameter of cylinder, in. (mm).

6.2.1.5 *S*—Ultimate tensile strength, psi (MPa).

6.2.1.6 *F*—Safety factor (see 6.1.1).

6.2.1.7 *T*—Cylinder wall thickness, in. (mm).

6.2.1.8 *E*—Tensile modulus of elasticity, psi (MPa).

6.2.1.9 *L*—Cylinder length between joints or elements that qualify as a stiffener, in. (mm).

6.2.1.10 *I*—Required moment of inertia for an element to qualify as a stiffener, in.^{3}(mm^3).

6.2.2 *Internal Pressure*:

$$T = \frac{PDF}{2S}$$

6.2.3 *External Pressure (Internal Vacuum)*:

Calculate:

$$1.73\left(\frac{D_o}{T}\right)^{0.5}$$

If result:

$$< \frac{L}{D_o}$$

Then use:

$$P = \frac{2.2E}{F}\left(\frac{T}{D_o}\right)^3$$

If result:

$$\geq \frac{L}{D_o}$$

Then use:

$$P = \frac{\frac{2.6E}{F}\left(\frac{T}{D_o}\right)^{2.5}}{\frac{L}{D_o} - 0.45\left(\frac{T}{D_o}\right)^{0.5}}$$

6.2.4 *Stiffeners to Withstand External Pressure*:

6.2.4.1 *Required Moment of Inertia*:

$$I = \frac{PL\,(D_o)^3\,F}{24E}$$

6.2.4.2 Material used to attach ring stiffener to cylinder wall may be included when calculating the actual moment of inertia of the stiffener as well as the portion of the cylinder wall beneath the stiffener and attachment material up to a width of 2 *x* (stiffener width).

6.3 *Rectangular Duct*:

6.3.1 The largest flat panel shall be designed to withstand the loading conditions and not exceed the design limitations (see 6.1.2). This can be accomplished with a sufficient wall thickness alone or by the incorporation of stiffening ribs to reduce the required wall thickness.

6.3.2 Appropriate calculations shall be run for wall thickness and stiffening ribs as determined by the manufacturer and the purchaser. Minimum wall thickness in all cases for rectangular duct shall be as in Table 1, substituting the longer side for the diameter.

6.3.3 The radial sides of a rectangular elbow shall be designed as a round cylinder with the same radius.

6.4 Follow the requirements of NFPA Bulletin 91, Section 510 when it is required by law or the engineer.

6.5 *Shop Drawings and Design Calculations*—The fabricated structure shall be in accordance with the design and construction details shown on shop drawings and design calculations prepared by the manufacturer and approved by the purchaser. Details to be covered include, but are not limited to, the following:

6.5.1 Materials, including a definition of the fiber-resin system, in accordance with types of resins and reinforcing materials of Specification C 582,

6.5.2 Dimensions,

6.5.3 Size and location of stiffening ribs,

6.5.4 Location of field joints and flanges, and

6.5.5 Type and location of supports, if supplied by the manufacturer.

6.6 All stiffeners, access openings, lifting devices or other appurtenances shall be included as part of the duct design.