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**CENTRIFUGAL CAST
CORROSION RESISTANT
FIBERGLASS TANKS**

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TABLE OF CONTENTS

- 1.0 Scope
- 2.0 References
- 3.0 Design
 - 3.1 General
 - 3.2 Shell, Heads & Joints
 - 3.3 Laminate
 - 3.4 Tank Connections & Appurtenances
- 4.0 Materials
 - 4.1 Resin
 - 4.2 Reinforcement
- 5.0 Drawings
- 6.0 Fabrication, Inspection & Testing
 - 6.1 Fabrication
 - 6.2 Inspection & Testing

CENTRIFUGAL CAST CORROSION RESISTANT FIBERGLASS TANKS

1.0 SCOPE

- 1.1 This standard covers the design, fabrication, and testing of fiberglass storage tanks for storage of liquids.

2.0 REFERENCES

- 2.1 All work performed and all materials furnished under this Standard shall conform to the applicable publications and standards of the organization listed below. Latest editions and revisions of the publications and standards listed below shall apply.

- 2.1.1 American Society for Testing and Materials.

2.1.1.1 Centrifugal cast glass fiber reinforced vinyl ester and polyester tanks shall be manufactured to meet the design strength specified in ASTM D-4097-01.

2.1.1.2 Classifying Visual Defects in Glass Reinforced Laminates and parts made there from, ASTM C582, table 5.

2.1.1.3 Test for Indentation Hardness of Plastics by means of a Barcol Impressor, ASTM D-2583.

- 2.1.2 American National Standards Institute-B16.5 Steel Pipe Flanges Flanged Fittings.

3.0 DESIGN

3.1 General

3.1.1 It is the object of this specification to provide as much design information as possible. Therefore it is intended that **Design Tanks** will have ample opportunity to utilize our particular "know-how" in the design and details of the tank fabrication in order to produce tanks which will be adequate for the intended purpose.

3.1.2 Details are often indicated without being fully designed. This permits **Design Tanks** to submit a design for approval, and it is intended that **Design Tanks** furnish a design based on the information given which will

meet the requirements of the job regarding strength, corrosion resistance, and practicality.

- 3.1.3 Tanks for installation outdoors should be checked for wind loading. Hold down lugs would be recommended for all tanks installed outdoors or where there are seismic requirements.
- 3.1.4 Other design requirements shall be considered such as stiffening in top heads, flange lips for agitated tanks, lifting lugs, etc. When required to meet a specified design.

3.2 Shell, Heads & Joints

- 3.2.1 Shell thickness design shall be determined based on a full tank of liquid. The standard tank is designed for a maximum liquid specific gravity of 1.3. Designs for other contents densities can also be provided.
- 3.2.2 For centrifugal cast storage tanks subject to hydrostatic head, the design stress shall be 10% of the minimum ultimate tensile stress of the selected laminate thickness thereby providing a factor of safety of 10:1 against shell or head rupture.

$$t = \frac{PD}{S_H}$$

t = wall thickness, In.
p = pressure, PSI
D = diameter, In.
S_H = design hoop stress
or S_H = S_U/10 where S_U is ultimate tensile strength.

- 3.2.3 For centrifugal cast tanks subject to hydrostatic head, the minimum wall physical properties are to be as follows:

CENTRIFUGAL CAST LAMINATE PHYSICAL PROPERTIES (minimum)

Tensile strength (PSI)	14,000 ASTM D638-96
Tensile modulus (PSI)	800,000 ASTM D638-96
Compressive strength (PSI)	18,000 ASTM D695-96
Coefficient of thermal expansion (in./in. degrees f X 10 ⁻⁶)	12 ASTM D696-91
Flexural modulus (PSI)	600,000 ASTM D790-96
Density (lbs./in. ⁻³)	.049 ASTM D792-91
Flexural strength (PSI)	19,000 ASTM D790-96

Procedure used in determining the properties listed shall be in accordance with applicable ASTM Standards using the method designated above.

- 3.2.4 Centrifugally cast tank sidewalls shall be internally bonded to the precast contact molded end sections while in the side wall mold to eliminate "out of round" and to insure a uniform smooth interior and exterior seam.
- 3.2.5 Centrifugally cast tanks shall incorporate a mold surface resin rich exterior finish.
- 3.2.6 On tanks equipped with agitators, suitable reinforcement of lips and wall shall be provided in order to supply required rigidity. The owner must supply agitator weights, downward loads, torque and bending moments, before a final design can be provided.
- 3.2.7 Open top, vertical tanks larger than 72" diameter shall be constructed with a horizontal flange lip at the top of the tank which shall be of sufficient rigidity to maintain the shape of the tank. Depending on use and tank height, a flanged lip is also recommended on smaller tanks.
- 3.2.8 Where top heads of vertical tanks are required to support operating personnel, auxiliary equipment or snow loads, stiffener ribs, thickening of heads or other means shall be used to provide structural rigidity.
- 3.2.9 Top heads of all vertical tanks shall be annular domed or dished unless otherwise specified on drawings.
- 3.2.10 All flat bottom, vertical tanks shall be continuously supported unless otherwise specified.
- 3.2.11 The knuckle radius of all flat bottom tanks shall be 1-1/2" minimum.

3.3. Laminate

- 3.3.1 An ultraviolet outdoor stabilizer can be incorporated in the final coat of resin or pigmentation if specified. The amount of stabilizer shall be per the resin manufacturer's recommendation.
- 3.3.2 Cut edges exposed to the chemical environment shall be coated with resin. The resin used shall be that designated in the tank design materials and must contain paraffin to assure adequate surface cure.
- 3.3.3 The laminate shall consist of an inner surface, an interior layer, and an exterior layer or structural laminate.

- 3.3.4 The compositions specified for the inner surface and the interior layer are intended to achieve optimum chemical resistance. This portion is also called the inner "corrosion barrier".
 - 3.3.5 The inner surface shall be free of cracks and crazing with a smooth finish and with an average of not over 10 pits per square foot, providing the pits are less than 1/8 inch diameter and not over 1/32 inch deep and are covered with sufficient resin to avoid exposure of inner surface fabric. Some waviness is permissible as long as the surface is smooth and free of pits. Between 7-10 mils of resin rich surface shall be provided. This surface may be reinforced with a synthetic fiber veil.
 - 3.3.6 A minimum of 90 mil of laminate is required in the corrosion barrier and will be reinforced with not less than 27 percent nor more than 33 percent by weight of noncontinuous glass strands having fibers lengths from 0.5 and 2.0 inches.
 - 3.3.7 The exterior layer or body of the laminate shall provide the additional strength necessary to meet the tensile and flexural requirements. Where separate layers such as mat is used, all layers shall be lapped a minimum of one inch. Laps shall be staggered as much as possible. The exterior surface shall be relatively smooth with no exposed fibers or sharp projections.
 - 3.3.8 The overall glass content of hand laminated construction shall be between 27 and 33 weight %.
 - 3.3.9 The laminate shall be allowed to cure to tackfree condition at ambient temperature prior to any post cure.
- 3.4 Tank Connections and Appurtenances
- 3.4.1 All connections on equipment and tanks will be FRP flanged or female NPT (threads) coupling unless otherwise specified.
 - 3.4.2 Hand lay up flanges are the standard and will be used on all flange connections, unless the owner specifies in writing something other than the standard.
 - 3.4.3 The machine facing of the back of the flanges is permitted. All bolt holes shall be spot faced for SAE size washers if required.
 - 3.4.4 Flange drilling on pipe connections shall be in accordance with ANSI B-16.5 for 150# bolting configuration.

- 3.4.5 Bolt holes in flanged nozzles are to straddle the vertical centerline.
- 3.4.6 A full face gasket and type 304 bolting hardware will be supplied as a **Design Tanks** standard with all blind flanges.

4.0 MATERIALS

4.1 Resin

- 4.1.1 The resin shall be selected by **Design Tanks**, based on the resin suppliers corrosion guide for the service specified.
- 4.1.2 For application requiring fire-retardant resins, the level of retardance shall be determined by the owner. Antimony trioxide will be added to the resin selected to meet the retardance level if required. (Not applicable to corrosion liner).
- 4.1.3 The resin used shall not contain fillers unless specified. When specified, up to 2 to 4% by weight of thixotropic agent Cab-O-Sil, or equal, may be used for viscosity control in the paraffinated top coat on vertical surfaces, provided it will not interfere with visual inspection.
- 4.1.4 The cure system will be catalyzed with MEKP (Methyl Ether Ketone Peroxide) with cobalt naphthenate and in some cases, DMA promoters as recommended by the resin supplier. All tanks fabricated to this specification shall be cured to at least 90% of the minimum Barcol hardness specified by the resin manufacturer. This requirement applies to both interior and exterior surfaces. (Note: The use of paraffin wax in the resin or the use of organic fiber veil may lower the Barcol hardness readings without necessarily indicating undercure.

A BPO (Benzoyl peroxide) curing agent system is provided for certain chemical contents where specified by resin suppliers.
- 4.1.5 Ultra violet absorbers and/or pigments may be added to the final resin exterior layer to improve weather resistance.
- 4.1.6 Wax must be added to the final resin layer in order to prevent air inhibition.
- 4.1.7 FRP tanks shall be designed and constructed to meet all requirements specified herein and shall be suitable for continuous, 24 hour/day service.

4.2 Reinforcement

- 4.2.1 The centrifugal cast tanks shall have a resin-rich interior surface.
- 4.2.2 Where services require, a type 1012 open Dacron polyester fiber 12 to 16 mils thick, as manufactured by Burlington Industries is utilized.

Thixotropic agents shall not be used for this service. Equivalent materials may be substituted if specified and agreed to by Owner.

Some of the services (contents) where the above is required are: hydrofluoric acid, hydro-fluosilicic acid, sodium hypochlorite, and sodium hydroxide.

- 4.2.3 Chopped strand mat shall be Type E (electrical borosilicate) glass, minimum 1-1/2 ox. per sq. ft., with silane finish and a styrene soluble reactive binder.
- 4.2.4 All materials shall be new and be of the best quality of their respective kind.

5.0 DRAWINGS

- 5.1 Upon acceptance of the purchase order, **Design Tanks** shall prepare specification sheets or approval drawings, for fabrications. These drawings shall be submitted to Owner for review and approval prior to the start of fabrication, unless approval is not required.
- 5.2 The tank service, tank overall dimensions and the **Design Tanks** name shall appear prominently in all drawing title blocks.
- 5.3 The detail drawings shall show the following:
 - 5.3.1 Location and details of all nozzle attachments.
 - 5.3.2 Type of resin.
 - 5.3.3 Thickness of shell and heads (if required for construction).
 - 5.3.4 Service temperature.
 - 5.3.5 Specific gravity.
 - 5.3.6 Nozzle schedule, including size.

- 5.3.7 Requirements for ladder, lifting, hold down, or support lugs.
- 5.3.8 Equipment capacity (gals).
- 5.3.9 UV Absorbers or other pigments, if applicable.
- 5.4 After review of drawings by Owner, any subsequent revisions will be notes on the drawing and approved by Owner.

6.0 FABRICATION, INSPECTION & TESTING

6.1 Fabrication

- 6.1.1 ASTM D-4097-01 is used as a design guide for tank construction.
- 6.1.2 All cured resin surfaces where parts are to be joined shall first be roughened by sanding or grinding. The roughened area shall extend beyond the work area so that no lay-up is made on a mold surface. Surfaces shall be clean and dry before lay-up. The entire roughened area must be resin coated when the joint is made.
- 6.1.3 All cut edges shall be coated with resin so that no glass fibers are exposed and all voids are filled.
- 6.1.4 The exterior surface shall be relatively smooth with no exposed fibers or sharp projections. Air bubbles, dry spots, pinholes, pimples and delaminations should be as defined in para. 6.2.3 of this spec.
- 6.1.5 Tolerances on tank diameter and height shall be in accordance with ASTM D-4097-01.

6.2 Inspection and Testing

- 6.2.1 **Design Tanks** shall make a dimensional check including nozzle dimensions or orientation, tank diameter, height, and thickness.
- 6.2.2 Evidence of cure will be an established Barcol hardness, which shall be no less than 90% of the resin manufacturer's recommended figure. A cured resin surface shall not become tacky when rubbed with an acetone impregnated cloth.
- 6.2.3 The level of laminate defects allowable shall be in accordance with ASTM C 582 table 5, "Critical areas" shall be regarded as the internal surfaces in contact with the process solution, flanges, and highly stressed areas such as supports, seams, knuckles, etc.

6.2.4 The owner shall be permitted access, upon request, to the plant area at all times during fabrication. Notification of owner prior to shipping can be arranged by specifying lead time on the purchase order.

6.2.5 **Design Tanks** shall maintain a quality control program adequate to insure that all fabrications comply with these specifications. All tests shall be witnessed by the quality control inspector.