The ASME Standard for Fiberglass Reinforced Plastic Vessels is Adopted into Delaware Code

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Delaware adopted as code the ASME International Standard RTP-1-2000, “Reinforced Thermoset Plastic (RTP) Corrosion Resistant Equipment,” into its civil code in accordance with the Jeffrey Davis Aboveground Storage Tank Act. The act was written in memory of a man killed when a sulfuric acid ($H_2SO_4$) tank exploded and collapsed in flames. Other standards exist that can contribute to the proper design of RTP equipment. These standards, however, do not provide equipment purchasers the documentation that shows whether or not vessels have been constructed according to a consensus standard that represents the best design, fabrication, and inspection technology for fiberglass-reinforced plastic (FRP) vessels available today.

Effective June 11, 2004, Delaware became the first state with a regulation requiring all aboveground fiberglass-reinforced tanks of 12,500 gal and greater, intended to store hazardous materials, to be designed, fabricated, inspected, tested, and stamped in accordance with ASME International Standard RTP-1-2000. This standard was developed under procedures accredited because they met the criteria for the American National Standards Institute (ANSI). The committee that approved the standard was balanced to ensure that individuals from competent and concerned interests had an opportunity to participate. The document is designed to set the minimum safety standards for the design and fabrication of composite vessels. Those with a material interest in the document had the opportunity to comment and voice their views to the committee. This consensus standard represents the best design, fabrication, and inspection technology for fiberglass-reinforced plastic (FRP) vessels available today.

The ASME RTP-1 Standard Committee meets twice a year. Any party with a material interest in FRP vessels is encouraged to attend meetings and to share ideas on how to improve the standard.

Many ASTM standards have been developed for the design of fiberglass vessels (Figures 1 and 2). One of the most commonly used specifications for filament-wound FRP tanks is ASTM D3299. This standard was first published in 1971 and is reedited and released every 5 years or so. The latest release is dated 2000.

During the 1970s, as the use of FRP vessels for corrosive service increased, many more specifications and standard methods were written to assist design engineers. The chemical plants where tanks were installed experienced an excessive number of failures, mostly related to construction. Because of these failures, several major chemical companies independently formed engineering groups that specialized in reinforced plastic equipment. They developed internal specifications. Some companies experienced improvements in their failure rate; others did not. Parts of these specifications made it into the public domain, and tank manufacturers found themselves trying to make vessels that required adherence to conflicting specifications.
It was not long before it was decided that all companies involved would see more improvements and less confusion from a standardized method for the design of FRP tanks. Thus, in the late 1970s an ASME committee was formed to establish rules of safety governing the design, fabrication, and inspection of FRP vessels. On December 31, 1989, ASME RTP-1 was published.

Provisions of the ASME Standard

ASTM D3299 was chosen as a reference point because it is a very common specification. ASME RTP-1 is more than a standard specification, however. It is a process that encompasses design, fabrication, and inspection. Only by linking all three parts of the process can the purchaser have the verifiable assurance that the vessel was constructed as intended. ASTM standards are voluntary and do not contain enforcement mechanisms to determine if the supplier meets the standard’s requirements. Provisions in ASME RTP-1 that are not found in ASTM D3299 are as follows:

- An ASME RTP-1 accredited supplier has undertaken an extensive qualification program to be able to offer ASME-stamped vessels. This includes an ASME-approved quality-assurance/quality-control (QA/QC) program, engineering, laminator certifications, demonstration laminates, demonstration vessels, and testing. In addition, ASME conducts “surprise” audits to ensure that the manufacturer is meeting the requirements of the standard.
- A vessel meeting ASME RTP-1 must have design calculations stamped by a professional engineer experienced in the design of RTP equipment. These calculations are based on actual physical testing of resin laminates at the design temperature.
- ASME RTP-1 requires an analysis of loading conditions such as lifting and anchoring the vessel, wind, seismic, snow, and man (point) loading, up-lift, etc., and the design factor for those events must be a minimum of 5 to 1. ASTM D3299 limits deflection on man-loading but does not address design factors other than limiting hoop strain to 0.001 in./in. (0.003 cm/cm). It does require “special consideration” but is not specific on the requirements for environmental conditions.
- ASME RTP-1 requires 50 psi-rated ANSI 150# drilled flanges. ASTM
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D3299 allows 25-psi-rated flanges. On larger-diameter flanges, 50-psi-rated flanges may cost more, but are stronger than 25-psi-rated flanges.

- ASME RTP-1 requires a hydrotest of the vessel prior to applying the stamp.
- If a vessel is designed for 2 psig or higher, ASME RTP-1 requires physical property tests for proof of design.
- ASTM D3299 is not valid for this pressure but is often used anyway, and proof of design is not required.

A complete data book including material traceability, testing, drawings, calculations, and details is prepared for an ASME RTP-1 vessel.

- ASME RTP-1 requires mandatory inspection at various hold points plus inspection of records relating to equipment design and materials used. The inspector must verify reinforcing sequence and inspect interior and exterior surfaces to detect laminate imperfections.
- ASME RTP-1 is applicable for +15 psig and full vacuum. ASTM D3299 is limited to a ±14-in. (36-cm) water column.

When an ASME RTP-1 vessel is delivered, it will have a full portfolio that contains the forms, calculations, and reports that cover the complete history of the vessel. It contains all of the information that went into the design, fabrication, and inspection of the vessel. It covers the complete history of the vessel fabrication—all of the information to assure the user that the vessel delivered meets the design criteria.

**Cost Factors**

**FABRICATORS**

As compared to an ASTM D3299 tank, the ASME RTP-1 vessel seems to have a lot of extra requirements. There are more inspections, professional engineering requirements, reports, and forms to fill out and file. A QA plan must be maintained and laminators and bonders must be qualified, etc., all of which add some cost to the tank. Most holders of ASME RTP-1 stamps have concluded, however, that their additional costs to produce a stamped vessel are very small. For some it may save money. When a vessel is constructed according to ASME RTP-1, it is built in exact accordance with specifications. The initial user’s requirements are spelled out in detail; this, combined with the professional engineer’s review of the drawings, minimizes miscommunication between the fabricator and user. This oversight has eliminated most costly “modifications” to the vessel. Many typical mistakes usually eliminated are noted below:

- Wrong veil in the liner
- Wrong catalyst used for the liner
- Physical properties used for design not achievable with the laminate used
- Questionable references for the design
- Not everyone quoted on the same conditions
- Inconsistent method of reinforcing nozzles and secondary joints
- No documentation provided for the materials of fabrication.

Implementation of the QA plan and the employment of qualified workers has shown that these typical laminating defects and procedural errors can be eliminated. The required quality control of materials helps ensure that the correct products are used the first time, inspections are made, and records are kept. Combined, these ASME RTP-1 features result in savings to the fabricator that more than make up for the cost of the program.

**PURCHASER**

Specifying a stamped ASME RTP-1 vessel can save the purchaser some expense. To ensure that a nonstamped vessel is made according to specifications, the purchaser must acquire the services of a
third party “expert” to perform design and QC functions. These functions are built-in requirements for ASME RTP-1. Many companies are reducing the size of their engineering staffs, and some may not have expertise in composite design. The standard’s requirement for a professional engineer to stamp the drawings relieves the pressure on many purchaser-engineering staffs.

There is a misconception that if a vessel is designed and built according to ASME RTP-1 but is not stamped, it will cost less and still maintain all of the attributes of a stamped tank except for the stamp itself. Some engineers will say that it is possible to design an FRP vessel this way, but it is not possible to build in accordance with ASME RTP-1 if one is not accredited. Without an ASME stamp, there is no assurance the vessel was made according to the design. Without an accredited ASME QA/QC program, there may not be any material traceability, no assurance the vessel was produced with certified laminators, and no proof that required tests and inspections were conducted.

Some major chemical companies are now purchasing ASME RTP-1-stamped vessels for most of their FRP tank requirements. Table 1 summarizes the justification of not only designing but also having the vessel built and stamped according to ASME RTP-1.

Also, with a nonstamped RTP-1 vessel, there is no documentation that the vessel meets ASME RTP-1, accredited by ANSI.

References

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