PRACTICAL GUIDELINES FOR SELECTING QUALITY FABRICATORS OF FRP TANKS AND PIPE

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COMPOSITES INSTITUTE

The Composites Institute of Australia is acutely aware that a composite structure which meets or exceeds its performance expectations represents the best possible stimulant to future industry growth. On the other hand, structures which exhibit premature failure or some other performance inadequacy, impact adversely on the reputation of both the industry and the material itself.

Virtually all cases of performance disappointments involving composites reported to the Institute can be traced to poor selection of component raw materials, design flaws, and/or inadequate fabrication techniques and controls. Sometimes this may involve calculated cost cutting measures aimed at securing a tender, but in many instances, the fabricator involved has simply over-reached his level of expertise and/or processing capabilities. Purchasing authorities, lacking an in-depth technical background in composites, can inadvertently contribute to the problem by accepting the lowest tender in the mistaken belief that they are achieving best value for their organisation.

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INTRODUCTION

Fibreglass reinforced plastic (FRP or. GRP) tanks and pipe are used in a wide range of corrosion resistant applications in the chemical, petroleum, off-shore, pharmaceutical and food industries. Buyers of FRP tanks and pipe should be aware of the very significant differences in the quality of the products on the market today. These differences are due to a number of key factors which can greatly affect the quality and resulting performance.

Unfortunately some purchasers of FRP tanks and pipe still assume that ***fibreglass is fibreglass is fibreglass***. This leads to the incorrect conclusion that the primary factor to be considered is price. In fact, fibreglass products vary widely due to resin properties, mechanical design, and fabrication techniques.

RESIN PROPERTIES

As is the case with corrosion resistant metals, there are large differences in the corrosion and the temperature characteristics of various resins .There are a variety of resins used for tanks and pipe including GP (General Purpose), Isophthalic Polyester, Bisphenol A Polyester, Vinyl Ester, etc. The purchaser of FRP equipment should verify that a suitable resin for the chemical environment at the design temperature has been selected. One highly recommended technique is to require the fabricator to supply a letter from the resin manufacturer verifying that the resin is suitable for the application.

A not infrequent problem among cut-rate fabricators is the substitution of an inferior (and therefore cheaper) or degraded resin for the correct resin. The results of substituting resin can range from shortened service life to catastrophic failure.

Unfortunately, after the equipment is fabricated, it is difficult for the purchaser to verify the type of resin which was used. When being questioned about a particular FRP fabricator, one end user commented "He is a pretty good fabricator but you have to go to his shop to make sure he is using the right resin" (actual quote).

The solution to this potentially disastrous problem is to identify and qualify quality FRP fabricators with a high level of integrity and avoid the fly-by-night, cut-rate shops. Sure, the quality fabricator will cost more. The quality fabricator uses the correct materials all in good condition. The cut-rate fabricator may use the wrong resin, may mix resins of different types, may use out-of-date resin, may use resin which will not polymerise properly, etc. and offer a low price. The resulting FRP products are actually the most expensive in the industry. One manufacturer of cosmetics in the eastern United States learned this lesson the hard way. A "lowest bid" FRP tank ruptured, resulting in the loss of US$800,000.00 of cosmetics. In addition to the enormous financial loss, company executives had to worry about the environmental impact of the spill.

DESIGN

FRP is non-ductile, has a relatively high strength and a relatively low modulus and may have anisotropic properties. A filament wound laminate may have an ultimate strength which is 1.5 times that of mild steel, but a modulus which is only 10% of steel. The low modulus makes FRP flexible, but more susceptible to buckling than steel. The experienced designer is aware of this, and designs accordingly.

The properties of FRP can be tailored to efficiently carry the design loads. Beams, for example, can be fabricated with a majority of the fibres in the longitudinal direction and a minority of the fibres in the transverse direction. One Asian fabricator of all-FRP light poles puts 4 times as many fibres in the axial direction as he does in the hoop direction. The result is a light pole which will carry large loads, and yet is light enough for two workers to carry.

The design engineer must be thoroughly familiar with the properties and behaviour of composites, and possess the tools to accurately predict the properties of the laminates.

Laminate properties can be accurately determined by published data (for certain standard laminates), lamination analysis software and through laboratory testing.

The purchaser of FRP should be aware of the widely accepted standards for FRP tanks and pipe. The early standards such as PS 15-69 still continue to be used, but have been replaced by far more detailed and more sophisticated standards and codes. The two most recent and most advanced standards are ASME Section X for FRP pressure vessels, and ASME RTP-1 for FRP storage vessels. ASME Section X is part of the ASME Boiler and Pressure Vessel Code.

Obviously the engineering resources of FRP fabricators vary greatly. Many of the sub-standard fabricators have no engineering resources whatsoever. The design is actually just a guess on the part of the owner or maybe even the production worker making the part. In these cases, the design does not conform to any industry standard, the safety factors are unknown, and the risks are high. The price may be low but the potential for a spill of corrosive, perhaps dangerous, materials is high. Does the advantage of the low price outweigh the long term risk? In most cases it does not.

Another important consideration is liability - professional liability on the part of the purchaser's engineering staff and managerial liability on the part of the purchaser's management. In some countries, spills of hazardous and toxic substances can lead to prosecution of the company' s engineers and managers if it is found that they have been negligent. A company which purchases FRP equipment from sub-standard fabricators who have no engineering capabilities may find it difficult to defend themselves against charges of negligence. On the other hand, a company which purchases FRP equipment from a quality fabricator with good engineering resources will probably never have a significant spill.

FABRICATION PROCESS

A steel tank fabricator forms tanks by cutting, rolling and welding steel produced by a mill. The steel is very uniform in thickness and has isotropic properties which are well defined. An FRP tank fabricator must take glass reinforcements and liquid resin and make the laminate as well as the tank. As a result, the quality of the finished product is very dependent upon the expertise of the fabricator, the attention to detail, and the equipment used in the fabrication process.

Due to the nature of FRP, a tank can be produced on one hand in a modem facility on a computer controlled winder or on the other hand outdoors on a plywood mould using a bucket and brush. Obviously, the resulting quality and performance of these products will be very different. Quality and performance are a function of the ability of the fabricator's personnel to:

1) Use good quality tooling which will produce dimensionally accurate parts with a good surface finish,
2) Place the correct reinforcements for the layers at the correct orientations,
3) Properly promote and catalyse the resin to give the correct gel time and cure for the fabrication conditions,
4) Correctly wet out the layers,
5) Roll out the air,
6) Apply the layers before gelling, and
7) Assemble the components.

Clearly, many sub-standard fabricators are unable to adequately perform some or all of these functions.

INSPECTION

The truisms that "you can't inspect quality into the product" and "prevention is better than cure" are very relevant to the purchase of FRP tanks and pipe. Some purchasers go for the lowest bid and then try to salvage quality products out of the deal by intense inspection of every step of the fabrication process. Obviously, these efforts meet with limited success and may, in the end result, be more expensive than starting with a reputable, quality fabricator. By selecting a quality fabricator, the need for inspection is minimised and the time required for inspection is significantly reduced. The quality fabricator will have complete and accurate records which the inspector can utilise. The quality fabricator will have a cooperative and knowledgeable staff to assist in performing the required inspections. Often the quality fabricator will have a good assortment of measurement equipment in good working order and in calibration which can be utilised by the inspector.

CONCLUSION

By developing an overview of the key factors involved in the design and fabrication of FRP tanks and pipe, the buyer can avoid inferior products. In most cases, the buyer gets exactly what he pays for when he purchases FRP tanks and pipe. A "cheap price" usually means a "seat-of-the-pants" design and poor fabrication quality which could lead to premature replacement, unscheduled maintenance, plant shut downs, catastrophic failures, environmentally dangerous spills, and hazards to employees and surrounding inhabitants.

The cost of any one of these will probably be far greater than the difference in price between the good quality fabricator and the poor quality fabricator. In reality, the most expensive price is the cheap price. The price of the quality fabricator is, in the long run, the lowest price. As the emphasis grows on employee safety, prevention of unscheduled down time and protection of the environment, this fact will become more and more important.

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