FRP VS. Rotationally Molded Polyethylene Tanks
For Chemical Storage Applications

Storage tanks used in the chemical industry come in a variety of models, types of materials. Two of the most common are fiberglass tanks (FRP) and polyethylene (PE) tanks. These two materials offer unique advantages for a wide range of chemical applications. When evaluating the tank design and material it is important to review the chemical compatibility, impact resistance, weatherability, overall cost, temperature, performance, vacuum or pressure requirement, stress crack resistance, environmental friendliness, etc.

In light of the wide diversity of performance characteristics, a comparative study of the benefits and features of each of these materials, especially in the storage of harsh chemicals, is appropriate.

Materials

The resin or tank material is a critical part of the tank design. The decision as to what material the tank is to be made of is determined by the actual application. When considering a polyethylene tank you have two families of resins. Rotationally molded tanks will be manufactured with either high density cross-linked (XLPE) or linear polyethylene. The cross-linked family of resins is limited to one cross-linked resin for rotational molding where the linear family of resins is available in low (LLDPE), medium (MDLPE) and high (HDLPE) density versions. The choice of the resin should be based upon the application and recommendations of the tank manufacturer.

When you consider a fiberglass (FRP) tank there are more resins and combinations of materials to consider. Polyethylene tanks are made up of one material. FRP tanks are a combination of materials in the laminate. A FRP tank will have a extensive offering of resin grades and types, pigments, fillers, resin cure systems, post cure requirements, inner corrosion barrier, interior layers, interior secondary layers, interior top coat, surface veil, reinforcement, sizing of reinforcement, percentage of reinforcement and the laminate construction (inner surface, interior layer, and structural layer).

Referring to a tank as fiberglass or FRP is like referring to a tank as plastic. There are numerous materials that can be called plastic and there are numerous combinations of materials and designs that are categorized as fiberglass (FRP). Fiberglass tank fabrication tends to have more potential for human error. The manufacturer’s expertise, consistency, quality assurance and qualified equipment are critical when specifying fiberglass and rotationally molded polyethylene tanks.

The cross-linked and the linear polyethylene resins have applications where they will both work. The high density linear (HDLPE) resin is utilized in the majority of the applications where both resins will work. The high density linear resin (HDLPE) is capable of meeting the requirements for FDA & NSF materials. The HDLPE resin is a repairable material by welding and it is a recyclable material. The cross-linked resin will be the resin of choice for applications such as polymers and surfactants.

Note: HDPE is a generic term which relates to both the cross-linked polyethylene and the linear polyethylene. HDPE stands for high density polyethylene. The cross-linked is only available in a high density version where the linear resins for rotational molding are available in low, medium and high density versions. When specifying resins it is important to consider the actual density of the resin to make sure that the correct resin choice is being made. Do not be fooled by manufacturers that reference all of their resins as HDPE.

Chemical Resistance

When selecting the material that the tank is to be manufactured from it is important to consider the chemical, the concentration of the chemical and the temperature.
FRP may be the material of choice for the storage of hydrocarbon-based or petroleum-based chemicals which are not recommended for polyethylene tanks.

When the liquid being stored is an oxidizer, FRP has its limitations and drawbacks. Polyethylene tanks, especially High Density Linear Polyethylene tanks (HDLPE) provide superior chemical resistance to oxidizing chemicals. The HDLPE tanks have no reinforcement, there is no interface between the resin and the glass fiber, a location in all fiberglass tanks that is an inherently weak area and is highly susceptible to chemical attack.

Rotationally molded polyethylene tanks are molded in one piece with a seamless construction offering a homogenous wall. This eliminates stress points or seams that are found in fabricated tanks. Fiberglass tanks are laminates of various materials. The laminate of a FRP tank can result in a wicking of the chemical through the laminate. There is a definite risk when choosing the FRP materials to form the laminate along with the variables in properly processing these materials.

One problem to consider when storing oxidizing chemicals is the potential increase in the corrosive nature and chemical attack of these liquids when they become contaminated. FRP tanks are susceptible to leaching of minor resin components by the action of these oxidizing chemicals. This contamination can have a direct effect on the final quality of the FRP tank. Delamination or cracking at the microscopic level, additional points of weakness or attack, can occur limiting the overall performance on the tank.

Rotationally molded polyethylene tanks that are designed according to ASTM D 1998-04 and manufactured of one resin they will not delaminate.

Polyethylene typically has a broader range of chemical resistance than FRP tanks. Applications such a acrylic emulsions, ammonium hydroxide, caustic soda, hydrofluoric acid, hydrochloric acid, photographic solutions, sodium hypochlorite, sodium peroxide, sodium thiosulfate, sulfuric acid and many more applications work extremely well with polyethylene. Today there is testing and technology to determine when polyethylene will work for an application. This data will help determine which polyethylene should be used, the wall thickness of the design and how the polyethylene should be processed. In some instances both the cross-linked (XLPE) and the high-density linear polyethylene (HDLPE) resins will work.

Mechanical Properties

FRP tanks tend to be more rigid than polyethylene tanks. Fiberglass tanks are a glass fiber reinforced resin. The strength of the laminate comes from the glass fibers. The concentration of glass fiber, the type of fiber and how the fiber is applied and oriented are determining factors as to the strength of the tank. FRP tanks may be fabricated in several ways. The most common manufacturing methods are hand lay-up; chop hoop, filament winding and combinations of these processes. Each of these processes has their pros and cons.

The FRP tank design will typically have a thinner wall than a polyethylene tank which will make the tank lighter. This benefit does come at a price. Polyethylene tanks are more resistances to impact than a FRP tank. The potential for impact damage in FRP tanks is made even worse by common variations in the manufacturing process. Failure to maintain uniform thickness, failure to regard ambient conditions/dew point, failure to apply each layer within specified processing window, improper cure, use of partially cured resins, and use of incompatible resin and fiber glass (sizing) will affect the FRP tank. Poor techniques and materials can cause the tank to delaminate and crack, which in turn compromises the mechanical properties, especially strength, stiffness and impact resistance of the FRP laminate. FRP tanks are pieced together so the seams result in stress and weak points which are areas subject to failure and leaks.

Note: It is interesting to note that the highest percentage of damage that occurs to FRP tanks is during loading/unloading from the manufacturer to the end user site.

Design Flexibility
The FRP process allows for tanks much larger that what can be manufactured by the rotational molding process for polyethylene tanks. FRP tanks are fabricated and pieced together so tanks larger than 20,000 gallon are very common. The largest rotationally molded tank is 16,500 gallon. Rotationally molded tanks are one piece seamless construction that are molded virtually stress free. The rotational molding process is limited to mold availability and equipment capacity. The rotational molding process allows for features to be molded into the tank such as flats, lifting lugs and tie-down lugs that normally need to be applied to a FRP tank in a secondary application.

Weatherability
Polyethylene will have better weatherability than a standard FRP tank. UV (ultraviolet) inhibitors and oxidation inhibitors can be compounded into the material by the resin manufacturers. Both polyethylene and FRP will perform well under very harsh environmental conditions. The FRP tank must be specified and built with a protective layer on the outside of the tank. Snyder uses only polyethylene resins that have the UV inhibitor compounded in from the start. The UV inhibitor in these polyethylene resins is throughout the entire tank wall.

Note: Polyethylene tanks can be designed to block UV from chemical applications that are sensitive to UV.

Quality Assurance/Manufacturing Reliability
Producing a high quality product that meets the design requirements of the end user is a goal all successful manufacturers strive for. This will be demonstrated by their quality assurance practices and procedures along with how they interact with their customer's needs and requirements. This is true for both FRP and plastic tank manufacturers. Snyder Industries takes great pride in its high quality products and loyal customer base. Snyder utilizes ASTM D 1998 in the design, manufacturing and testing of their line of Industrial Tanks.

The FRP manufacturing process is conceptually simple, especially for hand lay-up operations. It is quite difficult to maintain tight quality standards when using these lay-up manufacturing methods. The manufacturing of the FRP tanks may be improved by the use of filament winding which is a much more automated and reliable manufacturing process. With filament winding the number of variables in the manufacture of a FRP tank (resin, additives, fiberglass type, fiberglass sizing, human error, etc.) are more difficult to control than with the single resin and computer controlled processing equipment of a rotationally molded tank. A common practice with filament wound FRP tanks is to wind the cylindrical body and attach hand laid up end caps afterwards. This procedure results in seams that will not offer the same strength and chemical barrier as the filament wound section of the tank.