Beetle PLASTICS

CAPABILITIES. CAPACITY. SOLUTIONS.

Chemical Processing eBook:

FRP Applications, Opportunities and Solutions

Produced By: Beetle Plastics 2013

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Introduction

The world is in serious need of corrosion solutions. Each year it costs developed nations trillions of dollars in repair, maintenance and replacement costs. Industries such as oil and gas, chemical processing, pulp and paper, power generation, and wastewater treatment are impacted by equipment that cannot withstand hostile corrosive environments or worse equipment or infrastructure failure. In a 2009 study published by the World Corrosion Organization it was estimated that corrosion costs, worldwide, exceed 1.8 trillion dollars[1].

In another study conducted from 1999 to 2001 by CC Technologies Laboratories, Inc with support from the Federal Highway Administration (FHWA) and the National Association of Civil Engineers (NACE), it was revealed that the annual estimated direct cost of corrosion in the US was $276 billion dollars or approximately 3% of the nation's Gross Domestic Product (GDP)[2].

Fiber Reinforced Polymers are viewed throughout the world as part of the solution; FRP can be utilized effectively to optimize corrosion control practices and can be implemented as part of a broader cost-effective materials strategy. FRP materials can be formulated and designed to be corrosion and abrasion resistant; composites are known for withstanding the most stringent chemically corrosive environments and outperforming traditional construction materials of equal specifications on many fronts.

FRP materials are versatile and durable in nature. When engineered and employed properly they have the ability to enhance the robustness of corrosion control strategies by offering corrosion solutions in a broad range of service environments. Viewed by many as cost-effective corrosion resistant materials they can reduce both short and long-term costs and alleviate plant downtime, all while improving safety.

The Chemical Processing Industry is rife with more opportunities for FRP materials. FRP materials can provide legitimate corrosion resistant solutions for many chemical applications. FRP have successfully been utilized in chemical processing for decades and offer a strong benefits portfolio that includes long life cycles, high strength-to-weight ratio, dimensional stability and design flexibility, among much else. Industries are becoming acutely aware of the costs associated with corrosion and do want to be left in arrears—FRP is providing solutions to those looking to move forward.

[1] Global Needs for Knowledge Dissemination, Research, and Development in Materials Deterioration and Corrosion Control by Gunter Schmitt, May 2009, The World Corrosion Organization

[2] Corrosion Costs and Preventative Strategies in the United States

Intended Use of this eBook

The purpose of this eBook is to present meaningful information regarding FRP materials and applications in the Chemical Processing Industry (CPI). The information provided in this eBook is not intended to supplant recommendations or guidelines provided by resin manufactures. We hope this eBook will provide end-users of Fiber Reinforced Polymers (FRP), engineers and contractors with tools that are informative and user friendly. In addition, this eBook also serves as an informal introduction to Beetle's capabilities, capacity and solutions.

Beetle Plastics

Beetle Plastics, founded in the 1950's, designs and manufactures custom fiberglass pipe, large diameter fiberglass ductwork, fiberglass tanks, fiberglass vessels, other equipment and services which add value to your project.

Beetle Plastics is a manufacturer of fiberglass products who has become an industry leader in fiberglass technology.

Beetle Plastics is a subsidiary of Midwest Towers, Inc., a world-class manufacturer of evaporative water-cooling towers. Beetle Plastics operations include our headquarters and plant facilities in Ardmore, Oklahoma, and a nationwide network of sales and representative offices.

Beetle's Diverse Market Reach

Beetle brings an understanding of regulatory and quality standards, the environmental conditions as they affect FRP properties, as well as the economic underpinnings that impact manufacturing and production flow. We are a leader in custom FRP products because we understand the market challenges that are facing many end-users. We combine our comprehensive knowledge of FRP with precision capabilities to provide you with the most effective product solutions.

Snapshot of Beetle's Key Markets

- Power Generation
- Oil and Gas
- Chemical Processing
- Wastewater and Water Treatment
- Desalination
- Mining and Minerals
- Pulp and Paper

Capabilities and Capacity

We have the capacity, capability and technical know-how to provide custom Fiberglass Reinforced Polymers (FRP) materials and components, with precision—tailored to your specific needs. In short we provide turnkey solutions because everything is designed from start to finish with constructability in mind. More importantly, we go the distance to make sure we exceed your expectations in terms of quality and service.

Capabilities

- CNC Manufacturing
- Open Molding: Spray-Up and Hand lay-Up
- Precision Molding and Tooling
- Filament Winding
- Vacuum Infusion
- Press Molding

Engineering and Project Management Services

- Product and process review and management
- Feasibility reviews and design participation
- Project management
- Control plans, instructions, diagrams, and layouts
- On-site visits and field services support
- Project timelines and review of meetings
- On-target execution of services

We offer a full spectrum of capabilities that are as far reaching as they are innovative. What truly makes us competitive is our ability to take your ideas and needs and combine them with the knowledge and expertise of our engineers, drafters, project managers, and best-in-class manufacturing network to precisely build your custom FRP project and complete a successful launch of products to match your time targets and goals.

Field Services

- Procurement assistance
- Anchors, guides and support systems
- Maintenance inspections
- Supervision, repair and installation services
- Equipment rebuilding
- On-site modifications

The Beetle Advantage

With over 50 years of experience, we provide premier customer service that will pave the way for successful completion of your chemical processing project. Work with our team of expert engineers and dedicated technicians to create the custom FRP product that will move your business forward. As a leader in composites we're poised to solve your problems efficiently and cost-effectively.

We have unmatched design intelligence that can provide product development and support. At Beetle we can create new products as well as assist you with incremental improvements. FRP are widely used in the chemical processing industry because of their reliability, strength, low maintenance, affordability and design flexibility

Our strengths are inherent in our experience; comprehensive knowledge of composites and our precision capabilities. We will design, manufacture and build for your chemical processing needs. Our specialized resins are ideal for chemical processing and other industrial applications such as wastewater and water treatment, oil and gas, pulp and paper, and power generation to name a few. Whatever your need, our streamlined in-house design and manufacturing capabilities will enhance your product and improve your competitive edge.

Photo: Custom filament wound FRP tank

Capability – Beetle's numerous molding technologies and knowledge of resins gives you the broadest range of FRP composite options available

Capacity - Beetle has the management capability and manufacturing capacity to handle any quantity job and with any part size quickly, for custom fiberglass materials and components

Complete Solutions - Beetle delivers turnkey FRP solutions from design—build—Integration, on time and on budget for broad range of industries

Competitiveness - Beetle knows how to create custom FRP solutions that optimize performance and that deliver the benefits that make your business better

Constructability - Beetle has the experience to identify potential obstacles before the custom fiberglass products are built in order to avoid delays, reduce cost, and ease overall construction of the finished project

Our customers benefit from our experience because we know how to meet your specifications and exceed your expectations for project timing, design, integration, and finished-product quality. We offer unrivaled industry know-how and precision capabilities to help assist you with your specific challenges.

Photo: Power generation abrasion resistant piping for a limestone slurry scrubber system

Certifications

We Have the Experience to Execute and Deliver

Our manufacturing team includes certified professionals who have demonstrated high levels of skill, safety and precision. At Beetle we have invested time and resources into our personal to elevate our production performance and quality control.

We possess a high level of expertise at all stages of the manufacturing process. This fundamental approach, of offering the best training and education to our team, has developed a forward-thinking technical culture of highly skilled workers.

Certifications

OSHA 10, OSHA 30

ACMA Certified Composite Trained: Open and Vacuum Molding

Certifications (Bonder)

- ASME B31.3 Certified
- CCT Certified *(ACMA)*
- TWIC Certified
- OSHA Confined Space Certified

Work with our team of expert engineers and dedicated skilled technicians to create an enhanced custom FRP product that is cost-effective and corrosion resistant.

What are Fiber Reinforced Polymers?

Fiber Reinforced Polymers (FRP) have been defined using many terms. Around the world FRP also goes by other names often depending on market and or geographic location. Some examples include Fiber Reinforced Composites (FRC), Glass Reinforced Plastics (GRP), and Polymer Matrix Composites (PMC).

To keep things simple, here is a clear, concise definition. Fiber Reinforced Polymer composites are defined as a polymer (plastic) matrix, either thermoset or thermoplastic, that is reinforced (combined) with a fiber or other reinforcing material with a sufficient aspect ratio (length to thickness) to provide a discernable reinforcing function in one or more directions.

Four Main Ingredients of Fiber Reinforced Polymers

- Resins
- Reinforcements: Fibers and Forms
- Fillers
- Additives and Modifiers

Composition

There are four main ingredients that FRP are comprised of: resins, reinforcements, fillers, and additives/modifiers. Each ingredient is equally important and all ingredients play an important role in determining the properties of the finished FRP products. To simplify, think of the resin (polymer) as the glue or the binding agent. The mechanical strength is provided by the reinforcements.

Resins

The primary functions of the resin are to transfer stress between the reinforcing fibers, act as a glue to hold the fibers together, and protect the fibers from mechanical and environmental damage. Resins are divided into two major groups known as thermoset and thermoplastic. Thermoplastic resins become soft when heated, and may be shaped or molded while in a heated semi-fluid state and become rigid when cooled. Thermoset resins, on the other hand, are usually liquids or low melting point solids in their initial form.

Reinforcements: Fibers and Forms

Generally speaking there are four common types of fibers broadly used in the FRP industry: glass, carbon, natural, and arimid. Each has their advantages and applications. Similarly, reinforcements are available in forms to serve a wide range of processes, service and end product requirements.

Common materials used as reinforcement include woven roving, milled fiber, chopped strands, continuous chopped, and thermo-formable mat. Reinforcement materials can be designed with unique fiber architectures and be preformed (shaped) depending on the product requirements and manufacturing process.

Fillers

Fillers are used as process or performance aids to impart special properties to the end product. Some examples of inorganic fillers include calcium carbonate, hydrous aluminum silicate, alumina trihydrate, and calcium sulfate. In some circumstances fillers and additives can play a critical role in lowering the cost of compounds by diluting expensive resins and reducing the amount of reinforcements. Furthermore, fillers and additives improve compound rheology, fiber-loading uniformity, enhances mechanical and chemical performance, and reduces shrinkage.

Additives and Modifiers

Additives and modifiers perform critical functions despite their relative low quantity by weight when compared to the other ingredients such as resins, reinforcements and fillers. Some additives used in thermoset and thermoplastic composites include: low shrink/low profile (when smooth surfaces are required), fire resistance, air release, emission control, viscosity control, and electrical conductivity.

An important note is that FRP products can be custom made for their intended use. Understanding the intended function and services of the FRP, will aid the design and manufacturing processes to allow for an optimal finished product (i.e. corrosion resistance). Modifiers can include catalyst, promoters, inhibitors, colorants, release agents and thixotropic agents (i.e. fumed silica and certain clays).

Photo: FRP corrosion resistant tanker for transporting corrosive chemicals with customized components including grating, man way, rollover protection, valves, ports, and fittings.

Fiberglass Terminology

Anisotropic- Exhibiting properties with different values when measured in different directions. It can be defined as a difference, when measured along different axes, in a material's physical or mechanical properties (absorbance, refractive index, conductivity, tensile strength, etc.)

C-Glass- A Specialized corrosion resistant glass reinforcement used in the fabrication of the corrosion barrier or corrosion liner in FRP materials.

Contact Molded- Also known as hand lay-up, the contact-molded fiberglass process is typically comprised of a corrosion barrier that contains an inner surface and interior layer, a structural layer, and an outer surface. This initial resistant interior layer is significant because it provides a high-resin, low glass content corrosion barrier.

Corrosion Barrier- A resin rich veil layer that varies in nominal thickness depending on the service environment. Typically followed by random chopped strand mat or chopped strand roving; other subsequent reinforcements and scheduling may be utilized depending on the service environment or specifications. The high resin content of the corrosion barrier effectively shields the structural laminate from chemical attack. Inner layer and mat construction generally follow corrosion barriers for structural and mechanical purposes.

E-CR Glass- This type of reinforcement glass is similar in nature to E-Glass but does not contain boron or fluorine. Known for performing well in chemically hostile environments, specifically acidic and corrosive applications. E-CR glass is known to have higher temperature resistance, better mechanical properties, higher surface resistance, and better dielectric strength when compared to its predecessor E-glass.

Photo: 10" diameter FRP supply distribution header for chemical plant

Filament Winding-Filament winding is the process of winding resin-impregnated fiber or tape on a mandrel surface in a precise geometric pattern. This is accomplished by rotating the mandrel while a delivery head precisely positions fibers on the mandrel surface.

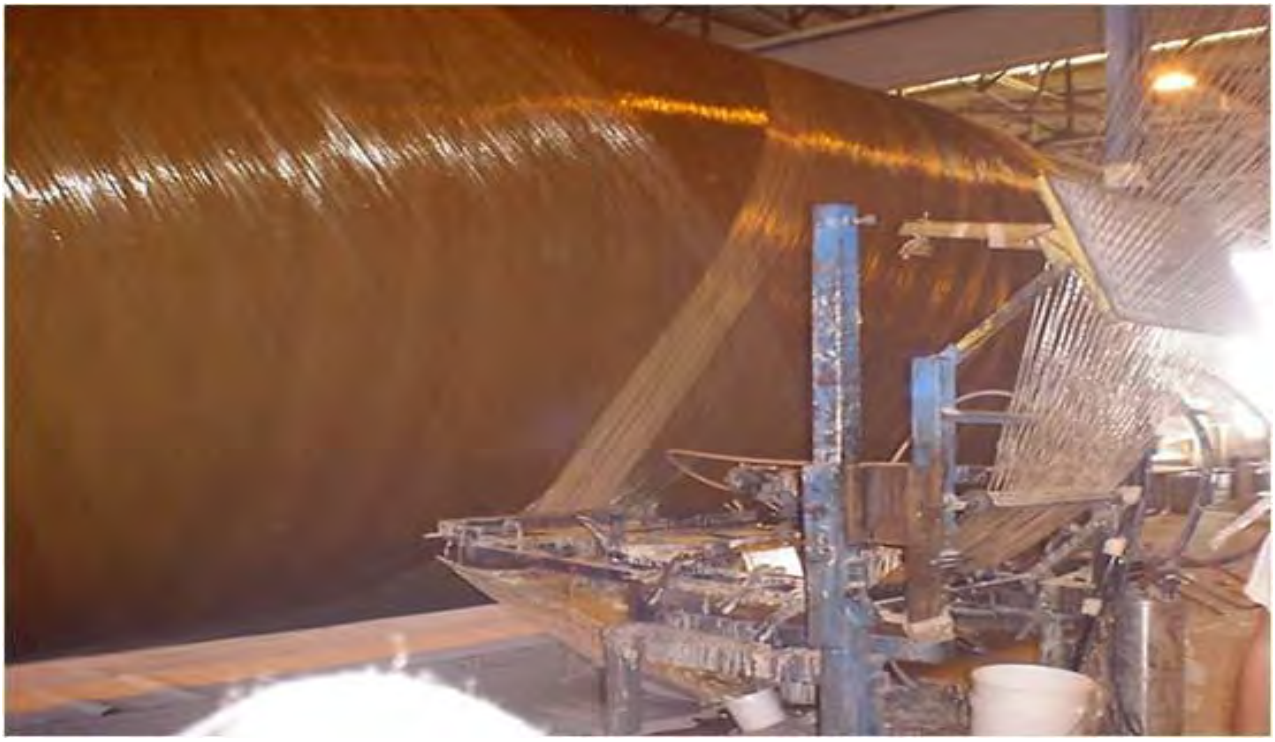


Photo: Filament wound pipe during the fabrication process

Hand Lay-up- One of the basic fiberglass fabricating techniques. The hand lay-up process uses a combination chopped –glass mat and woven continuous glass filament layered together with resin.

Spray-up- This process is similar in nature to hand lay-up and is also included in the general category of contact molding. Simply put, the spray-up process is an automated way of depositing chopped glass onto a structure. The spray-up process is particularly useful when filling a cavity or when glass mat or weave are too stiff for the design specifications.

Polymer- Polymers are substances whose molecules have high molar masses and are composed of a large number of repeating units. There are both naturally occurring and synthetic polymers**.** Composite materials are made up of a synthetic polymer matrix that is reinforced. Examples of synthetic polymers include epoxy, vinyl ester or polyester thermosetting plastic resins.

Reinforcement-Many different reinforcements may be used during the fabrication of FRP materials including polyester fibers, natural fibers, carbon fibers, arimid fibers, and glass fibers. The arrangement and combination of fiber reinforcements, along with resins, will in large part determine many of the characteristics of your final product. Examples of reinforcement types are surfacing mat, reinforced mat, chopped fibers,

woven fabrics, woven roving, and continuous strand roving.

Resin- Broadly defined, resins encompass a large class of synthetic products that have some of the physical properties of natural resins but are different chemically and are used chiefly in the manufacturing of plastics, fiberglass and other composites. Typically each resin has its own characteristic properties.

Surfacing Veil- Typically a very thin sheet of synthetic polyester or very fine C-glass. This veil layer can be designed to impart corrosion and abrasion resistance and frequently is used for the surface of FRP equipment that will come into contact with the corrosive or abrasive environment.

Thermoset Resins- Refers to a large class of synthetic resins used in the fabrication of FRP products. A thermosetting type resin once formed cannot be reformed and generally speaking will not melt or flow.

Vacuum Infusion-Is a process that uses vacuum pressure to drive resin into a FRP laminate. Materials are laid dry into the mold and the vacuum is applied before resin is introduced. Once a complete vacuum is created it allows the resin to be infused into the laminate. Any excess resin may be sucked out of the laminate using a similar vacuum process.

Photo: Hand spray-up process; technician applying chopped filament to form

FRP Benefits

FRP have been utilized effectively in a multitude of industrial and non-industrial applications including power generation, mining and minerals, pulp and paper, chemical processing, oil and gas, wastewater, water purification, desalination, aerospace, pharmaceutical, food and beverage, military, agricultural, and architectural—to name a few. FRP are recognized for the ability to withstand acids, bases and organic compounds.

Key Benefits of FRP

- Corrosion and Abrasion Resistant
- High Strength-to-Weight Ratio
- Dimensional Stability
- Ease of Installation
- Long Service Life; reduced maintenance costs
- Cost-Effective
- Durability
- Noise Reduction
- Part Consolidation
- Heat Resistance
- Smoke and Flame Retardancy
- Thermal Conductivity and Insulation

Photo: Custom FRP piping

FRP Technology

There is global demand for FRP products that can perform in unique and often stringent environments. FRP materials and equipment are commonly sought after throughout the world for their ability to withstand highly corrosive and abrasive environments, prolonged exposure to heat, high strength requirements or any other circumstance where conventional construction materials have failed or fallen short. Technological advances in the past 50 years have made FRP a superior material choice for nearly a limitless amount of applications.

FRP materials and equipment are currently filling many niches as high quality, customizable, cost-effective products. They have successfully done so because they have proven to be a worthy alternative to other traditional materials such as concrete, metal, and wood. This can be said throughout many markets especially in industrial settings, such as chemical processing, aerospace, marine, and construction.

Corrosion Barriers

Each service environment is unique and therefore requires specific design and engineering considerations. The corrosion barrier is typically fabricated with a resin-rich liner or corrosion barrier, followed by a glass-rich structural wall. The corrosion barrier is one component of the entire laminates schedule, but it is a critical structural layer that must be designed properly in order to optimize the performance of your FRP product. You should always discuss resin selection with a resin manufacturer, engineers or an FRP manufacturing company. Corrosion barrier/liner considerations and resin selection are extremely important to the overall design of your composite product.

To be more specific, the corrosion barrier is typically a combination of one or multiple plies of resin-saturated C-Glass or synthetic veil against the process surface, followed by two or more plies of chopped glass fibers or chopped strand mat. Other surface veil materials common in the industry are E-CR Glass, Polyester and Carbon. The job, service environment and operating conditions will affect which barrier materials are recommended.

Typical Functions of the Corrosion Barrier

- Corrosion resistance
- Abrasion resistance
- Chemical resistance

Each resin rich layer acts as a defense against chemical attack; generally speaking layers vary from 75%-90% resin by weight, however formulations may vary

depending on design specifications. For example, the corrosion barrier and structural layer will vary in thickness depending on the intended use (i.e. aggressive chemical environments and elevated temperatures). The corrosion barrier provides little or no mechanical properties of the laminate and is primarily used to protect or shield the structural portion from the corrosive environment.

As corrosion costs take their toll and as metal prices continue to rise, traditional construction materials such as stainless steel or coated steel are being replaced by cost-effective FRP products. Similarly, the corrosion resistance performance of FRP is exceptional when compared with traditional or common metal alloys. For example, FRP performs well in hydrochloric acid and sulfuric acids—among many others.

Table 1. FRP Corrosion Performance

Corrosion Performance	FRP	2205SS	C-276 Alloy
Hydrochloric Acid	90° C to 15% concentration	60° C to 1% concentration	80° C to 15% concentration
Acid Chloride Salts	100° C in all concentrations	65° C with 2,000PPM @ low pH levels	65° C with 50,000PPM @ low pH levels

Source: "How to Use FRP to Lower Corrosion Costs," Owens Corning

Photo: Custom FRP tank for acid service environment (top view)

Photo: Custom FRP Tank for acid service environment with custom small diameter piping, valves and fittings (side view)

Corrosion Barrier Compositions of FRP Chemical Process Equipment

According to a 2003 case study published by Ashland Specialty Chemical Company, when addressing FRP design considerations and requirements inherent to chemical processing applications it is critical to address three typical types of barrier functionality in order to achieve optimization of the service life of he FRP equipment[3].

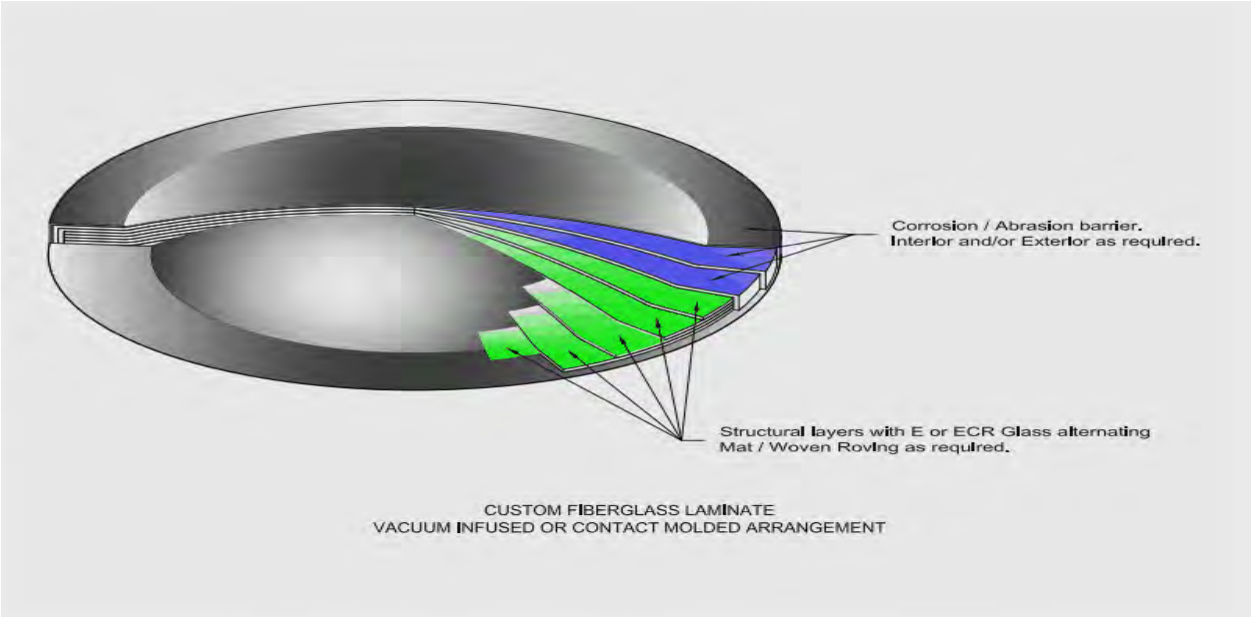
The three typical types of barrier/liner functionality are:

1. Chemical Resistance
2. Electrical Conductivity
3. Abrasion Resistance

Paramount to creating fully optimized FRP equipment with corrosion resistance other design elements and factors such as temperature, concentration, pressure, vacuum, and environment must be incorporated into the design, engineering stages and fabrication processes.

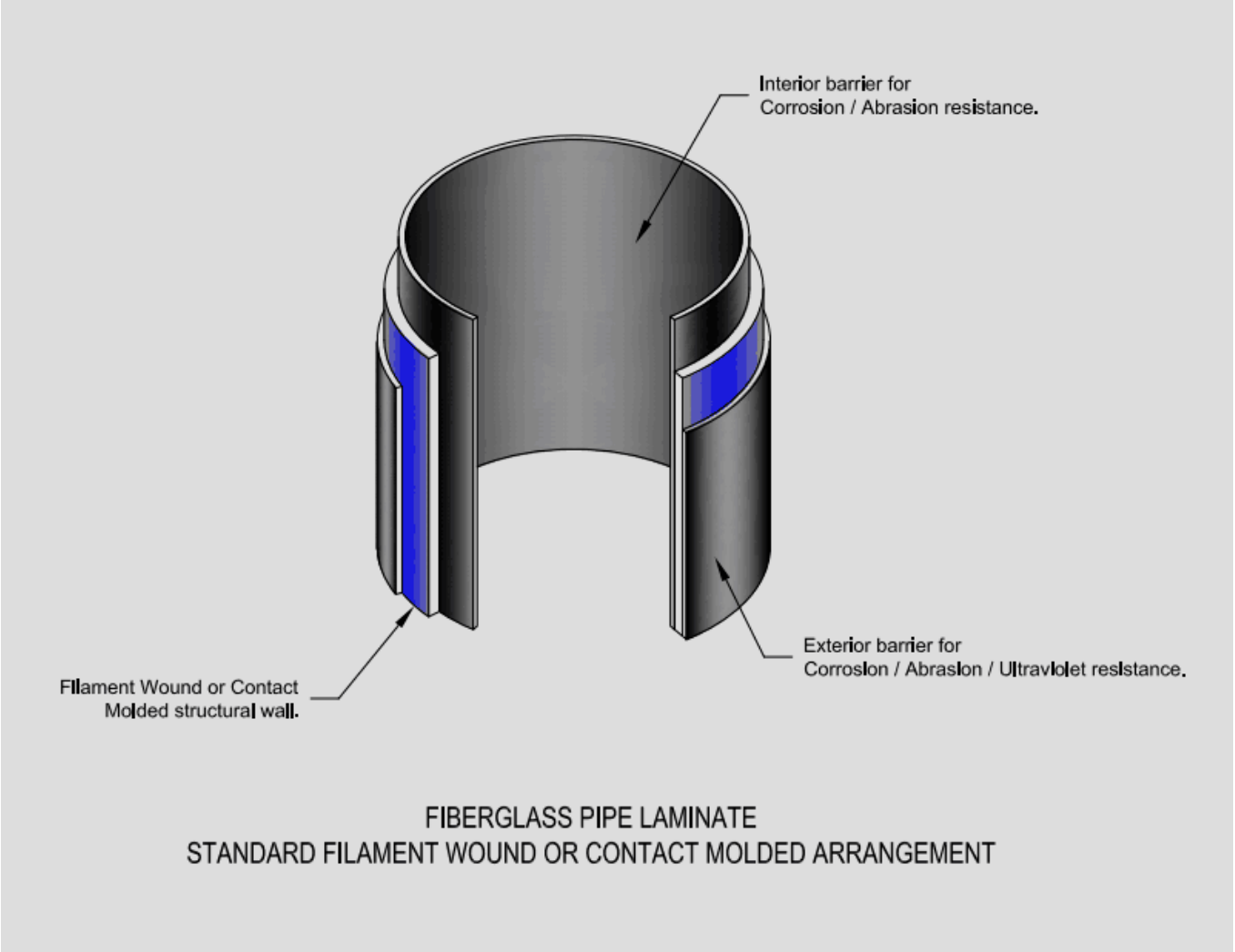
For example, selecting the proper materials for the surfacing veil as well as the overall laminate schedule will have an enormous impact on service life. Similarly, resin type, fillers, modifiers, cure system, post-cure system, as well as other design and manufacturing elements will affect the corrosion resistance and the effectiveness of the FRP material to withstand chemically hostile and stringent service environments.

Illustration 1. Custom FRP laminate vacuum infused or contact molded arrangement with corrosion/abrasion barrier



[3] "Corrosion Barrier Composition of FRP Chemical Process Equipment," Gleditsch, 2003, Ashland Specialty Chemical Company, paper no. 03619. NACE

Illustration 2. FRP pipe laminate filament wound or contact molded arrangement



Beetle's Advancements in Fiberglass Technology

Snapshot History of Beetle's Abrasion and Corrosion Resistant Advancements

- Beetle Plastics and Jack Mallinson, FMC's Plant Fort Royal, Virginia team-up in the 1960's and 1970's to improve fiberglass and resin technology.
- Corrosion and abrasion resistance enhanced with the discovery that adding armoring modifiers improved performance
- Beetle begins working with Walt Szymanski of Hooker Chemical in the 1970's and makes major advancements in the technology of abrasion resistance in FRP composites, including the discovery of specialized fabrication techniques that optimize the effectiveness of the resin matrix.
- Beetle and Hooker Plastics conduct extensive testing to further enhance fabrication techniques.
- Beetle begins using special developmental elastomeric and acrylic modified epoxy resins while working with DOW Chemical and Interplastics to further investigate experimental resins.
- Testing determined that selection of the proper resin, along with specific resin modifications, was found to increase abrasion resistance by a factor of two to three times over a standard polyester or epoxy resin.
- During further research and development with Hooker, Dow Chemical and Interplastics, It was found that a specific combination of selected reinforcements was critical to obtaining the optimum abrasion resistance. As the result of that knowledge, Beetle Plastics LLC now uses a unique combination of laminate reinforcements that help significantly improve the total abrasion resistance of the composite laminate.
- Beetle successfully develops a new type of armoring modifier that provided superior armoring of the FRP composite. This material is related in toughness to basalt, which in its natural form is often used as abrasion liners for steel pipe. Over the years, Beetle Plastics has fine-tuned the specific grades of this armoring modifier material, selecting those that demonstrated the best performance in abrasion resistant FRP pipe.
- Beetle further went on to developed techniques to gain the optimum dispersion and wetting out of this armoring modifier within the resin. Getting this ideal resin "hook" to the armoring modifier is also an important consideration when developing the best possible abrasion resistance of FRP laminates.
- Beetle continues to refine its abrasion and corrosion resistant technology including its custom corrosion barriers.
- Beetle goes onto develop high-performance custom fiberglass pipe and duct and other equipment that includes FRP materials for severely corrosive environments.

Chemical Industry Outlook, Challenges and Opportunities

The global chemical industry, a 3 trillion dollar enterprise that effects nearly all other sectors of the economy, continues to face a number of questions as well as trends that will drive opportunities and growth. In recent years the US has quickly positioned itself as low-cost natural gas producer and net exporter of chemicals. New global trends that continue to offer opportunities include growth in new markets, shale gas discoveries and New Materials Systems[4].

Many economist and consulting firms have pointed to the opportunities for North American petrochemical manufactures as well as the ripple effect of benefits downstream especially by industries fueled by low cost inputs. Sluggish global economic growth is projected to keep the US market growth at 1.9% and Europe at .5% respectively[5]. Demand in China continues to grow but at a much slower rate than the previous 10 years; overcapacity, the global economy, and China's chemicals sector entering maturing stages are possible explanations.

The offset of petroleum and natural gas has given North American companies access to cost-advantaged feedstocks, which in turn can provide lower-cost manufacturing and help to create resurgence in the US among commodity producers looking to capitalize on lower-cost production opportunities. For example, over $US40 billion dollars of investment have been announced in the chemical processing market[6]. Despite this sliver of good news to the North American Chemicals Market many global financing considerations loom overhead. For example, how will the uncertainties of the global economy and ongoing European Sovereign debt issues impact investments?

FRP and Chemical Processing

The Chemical Processing Industry (CPI) is diverse in nature. The transport, handling, storage, and manufacturing of corrosive chemicals demands attention be paid to the materials of choice for construction. Sulphuric acid, hydrochloric acid, sodium hypochlorite, chlorine (**Appendix 1 Beetle Case Study**), other caustics, organic solvents, and industrial waste require careful design and engineering considerations to ensure safety and optimization of product. Regardless of the chosen construction material, the requirements of the job, service environment, operating conditions, and specific application will have an important role in design.

FRP have been employed in wide range of equipment and specific chemical

[4]Deloitte Touche Tohmatsu Limited (DTTL) Global Manufacturing Industry group, Reigniting Growth: Advanced Materials Systems, 11 December 2012, www.deloitte.com/reignitinggrowth

[5] 2013 Outlook for global Chemical Industry, Chemical and Engineering News, Jan 16, 2013

[6] Houston Chronicle, "Industry leaders: Domestic oil, gas are driving U.S. manufacturing resurgence," 2 November 2012, http://www. mywesttexas.com/business/oil/article_aa1aaeed-5bd6-585f-ab94-e301a5116721.html

applications. FRP materials have been successfully used for pipes, ductwork, storage tanks, absorption towers, drying towers, solvent extraction vessels, gas scrubbers, packed reaction columns, pressure vessels, process reaction vessels, stacks, process containment equipment, packing support systems, packed bed distributors, bed limiters, and distributor feed headers—to list some examples.

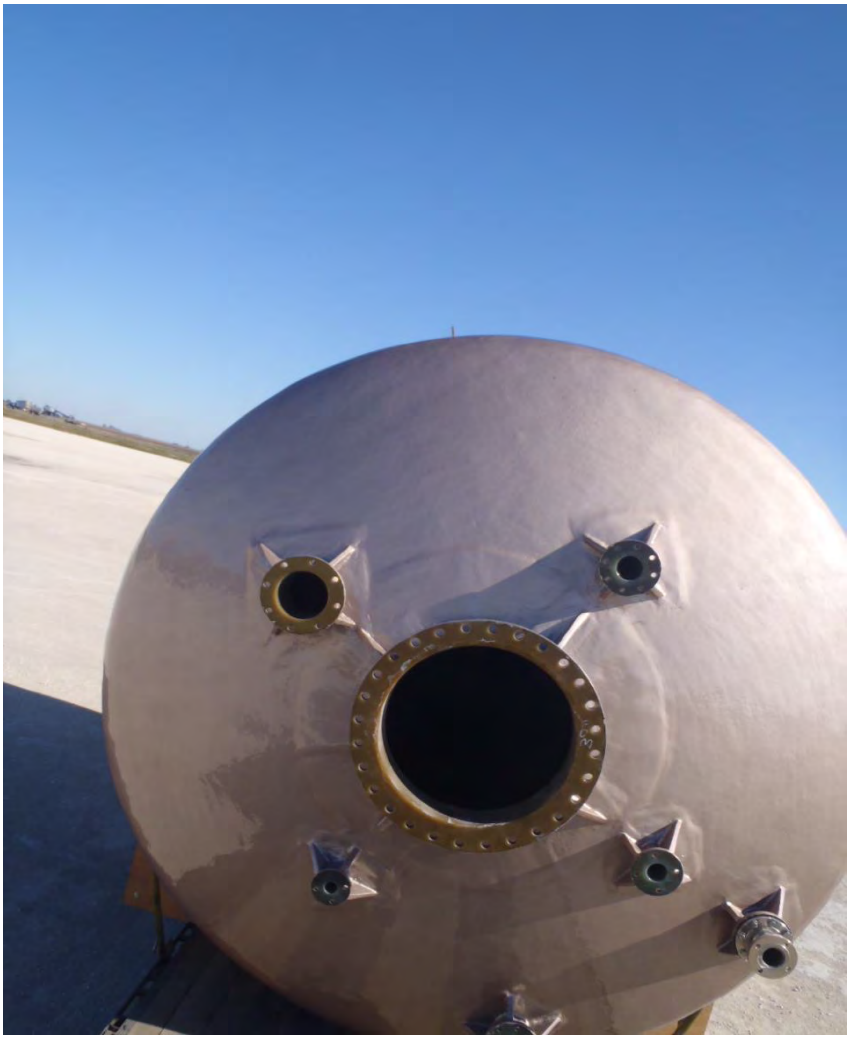


Photo: Custom FRP Tank

FRP are utilized worldwide for applications in chlorine, sulphuric acid, biological transformation, fertilizer, petrochemical, and mining and mineral plants. They can be used in separation processes such as filtration, settling (sedimentation), extraction or leaching, distillation, recrystallization or precipitation, drying, and adsorption.

Regardless of whether you produce organic and inorganic chemicals, phosphatic and nitrogenous fertilizers, alkalis and chlorine, industrial gases, plastic materials (nonvulcanizable elastomers and resins), synthetic rubbers (vulcanized elastomers) paints and pigments, coatings, or detergents, the benefits of using FRP may interest you. FRP can be utilized cost-effectively with catalysts, chemical by-products, chemical intermediates, chemical products, chemical reactions,

feedstock or raw materials, and unit operations.

FRP has a distinct advantage over metal alloys, such as titanium, and rubber-lined steel with lower installation costs, reduced maintenance, and long service life proven—with over 20+yrs of successful operating experience at many plants/facilities around the world. More importantly, FRP is recognized as having superior corrosion resistance and abrasion resistance when compared to specialty alloy metals, in stringent chemical processing and in aggressive hydrometallurgical environments.

In general carbon steel and stainless steels are susceptible to many different types of corrosion and or chemical attack and thus pose serious limitations to the end-user. Similarly, titanium and other metals may offer improved performance in chemically aggressive and corrosive environments may be cost-prohibitive. FRP are cost-effective materials that provide, durability, abrasion resistance and corrosion resistance. Furthermore, in an industrial setting FRP offer good cleaning properties and long life cycle cost analysis (Lyons, 2007).

Table 2. FRP Corrosion Resistance Using Epoxy Vinyl Ester Resins

Materials	Sulfuric Acid	Hydrochloric Acid	Acid Chloride Salts
FRP Made with Epoxy Vinyl Ester Resin	100˚C to 30%	80˚C to 15%	100˚C all conc.
Stainless Steel 2205	30˚C to 30%	60˚C to 1%	65˚C to 2000ppm @ lower pH
Alloy C-276	100˚C to 30%	80˚C to 15%	65˚C to 50ppm @ lower pH

Source: "The Use of Phosphate Fertilizer and Sulphuric Acid Processes" Ashland Performance Materials, Case Study, 2007

FRP continue to become more popular for chemical processing applications tanks, reactors, pipes and columns for the production of chlorine gas, hydrochloric acid and hypochlorite are a few examples of successful applications. Similarly FRP pipelines and pipe systems have been effectively employed to transport waste gas, wastewater and hydrochloric acid. FRP has provided many solutions to one common problem—corrosion. Long-life cycles, high strength-to-weight ratio, dimensional stability, fatigue resistance, reduced maintenance costs and tailor-made fabrication possibilities have made this the go-to construction material for a variety of industries including chemical processing, power generation, wastewater treatment, pulp and paper, and metallurgy.

FRP Applications in the Chemical Processing Industry

In Chemical Processing FRP are utilized to fabricate the full spectrum of products including pipes, ductwork, storage tanks, absorption towers, drying towers, solvent extraction vessels, gas scrubbers, packed reaction columns, pressure vessels, process reaction vessels, stacks, process containment equipment, packing support systems, packed bed distributors, bed limiters, and distributor feed headers—to list some examples.

FRP Can Be Employed in a Range of Chemical Processes

- Chemical and mechanical filtration
- Settling, extraction or leaching
- Distillation
- Recrystallization
- Precipitation
- Drying
- Absorption

Photo: Fume transfer ductwork (electrically conductive) for pharmaceutical application

Table 3. Examples of FRP Chemical Applications

FRP Chemical Applications
Aluminum Hydroxide
Ammonia
Ammonium Nitrate
Calcium Carbonate
Carbon Dioxide
Chlorine
Cumene
Diammonium Phosphate
Ethyl Alcohol
Ethyl Benzene
Hydrochloric Acid
Phosphoric Acid
Potassium Hydroxide
Sodium Hypochlorite
Sulfur Dioxide (gas wet or dry)
Sulfur Trioxide

Each service environment is unique and requires special attention to engineering considerations **(Appendix 2. Common FRP Design Considerations List).** Special considerations such as concentration, temperature, pressure, vacuum will need to be addressed to ensure that the product being fabricated is optimized to enhance its performance and meet your specifications. To a large degree your service environment and specifications will influence many important design elements such as resin selection, laminate schedule and corrosion barrier.

The corrosion barrier is typically fabricated with a resin-rich liner or corrosion barrier, followed by a glass-rich structural wall. The corrosion barrier is one component of the entire laminates schedule; it is a critical layer that must be designed properly in order to ensure effectiveness, safety and performance of your FRP product. Although the corrosion liner does not provide much in terms of mechanical properties it's extremely important to the overall design of your composite product.

As an example, to illustrate to design flexibility and utility of FRP materials consider

a sulphuric acid plant, which would require piping, ductwork, tanks, and scrubbers—a large project, with high levels of corrosion.

Beyond just the broad categorization of FRP equipment for a sulphuric acid plant or other chemical processing applications here are some specific examples of possible FRP equipment:

FRP Equipment for a Sulphuric Acid Plant (Examples)

- Start Stack
- Strainer
- Processing Tanks
- Settling Tanks
- Droplet Separator
- Gas Cooling Tower
- SO_2 Stripping Tower
- Wet ESP Flushing Tanks
- Sodium Silicate Tanks

Regardless of whether you are constructing a chlor-alkali plant, chlorine dioxide plant, or building an HCL absorber vessel, or an HCL storage tank for nickel processing—FRP can provide a wide range of corrosion solutions. FRP is sought after for its corrosion resistant properties in a wide range of industries including pulp and paper, power generation, pharmaceuticals, wastewater treatment, mining and minerals, and chemical processing—to name a few.

Photo: Petrochemical plant

FRP Chemical Processing Equipment

When designed properly FRP can provide excellent high-temperature capabilities and solvent resistance. Depending on resin selection and other design factors, unique characteristics may be enhanced. In general, FRP withstand many acids, alkalis and oxidizing chemicals.

Table 4. Examples of FRP Equipment for Chemical Processing Applications

Common FRP Equipment	General Applications
Tanks	Batching, Electrowinning, Fuel, Plating, Pickling, Processing, Recovery, Remediation, Storage, Transfer, Waste and Effluent
Vessels	Solvent Extraction Vessels, Process Reaction Vessels and Pressure Vessels
Pipe	Chemical Piping Systems and Pipe Support Systems, Solution piping, Hot and Wet, Leach Field, Stock and Effluent
Duct	Chemical Duct Systems, Fume Duct, Transport Duct, Odor Control Duct
Other Components	Headers, Mist Eliminators, Chlorine Absorbers and Scrubbers, Hydrolizers, Dechlorinators, Strippers, Cell Covers and Collectors, Washer Drums and Up-Flow Tubes, Process Equipment, Fans, Blowers, Hoods, Impellers and Fan Housings
Surface Protection and Secondary Containment	Secondary Containment and Liners, Floor Coverings
Pultruded	FRP Pultruded Hand Rails, Stairs, Crash Rails, Grating, Roofing, Conduit Trays, Structural and Form Shapes

FRP Materials and Industrial Applications

FRP materials have become ubiquitous in many industries the world over because of their cost-effectiveness, corrosion resistance, high strength to-weight ratio, long life cycles and design flexibility. FRP materials and equipment have been employed successfully in some the most chemically hostile and stringent service environments. From power generation to wastewater treatment, from pulp and paper, mineral extraction, and oil and gas—they have surpassed many traditional construction materials in both terms of performance as well as cost competiveness.

Case in point, the world's largest nickel mine located on the African island of Madagascar set for completion in 2013, will consume miles of FRP piping and require specialized tank covers for sulphuric acid vapor environments[7]

Table 5. Cost Comparison of Construction Materials

Construction Material	Cost	Cost-Ratio
Shop Fabricated FRP	$US 40 - 50/sq. ft.	0.9 - 1.0
Field Fabricated FRP	$US 60 - 70/sq. ft.	1.2 - 1.4
2205 Stainless Steel 3/8" plate	$US 150 - 225/sq. ft.	3.0 - 4.5
C-276 Clad Carbon Steel	$US 230 - 330/sq. ft.	4.6 - 6.6

Source: Ashland Corrosion Chronicle, Spring 2011

FRP has many other important advantages besides initial price that are critical to production flow maintenance and long-term costs. For example FRP can often be more easily sourced than specialty metals which can have a tremendous impact on order turnarounds and construction scheduling. Similarly, many industries view FRP as superior materials for their design flexibility, reduced maintenance costs, as well as larger and more diverse storage capabilities.

In another example, FRP materials have been utilized by one of the world's largest producers of pharmaceuticals[8]. In this case a custom FRP scrubber and quench tower were fabricated to treat corrosive waste gas, flue gas and organic waste. The FRP equipment was designed with a heat and corrosion barrier to withstand the hot flu gas environment and extreme corrosive chemical attack.

[7] "The Corrosion Chronicle," Ashland, Spring 2011
http://www.ashland.com/Ashland/Static/Documents/APM/CorrosionChronicle_spring11.pdf
[8] "The Corrosion Chronicle," Ashland, Fall 2010
http://www.ashland.com/Ashland/Static/Documents/APM/CorrosionChronicle_Fall2010_PC-10800.pdf

FRP Design Versatility

When you combine the versatility of FRP with intelligent design that imparts constructability the options are limitless. FRP are ideal for a multitude of CPI and other industrial applications. For example, there are many opportunities such as plant construction, process expansions, unit and equipment additions, upgrades, conversions, modernizations, rebuilds, renovation, retrofit, debottlenecks, and major maintenance turnarounds.

Photo: Custom FRP tanks and saddles with ports and valves for fuel storage

Photo: Custom FRP tank for corrosive services

FRP Materials for Wastewater and Water Treatment Chemicals

We offer great FRP materials that perform well in wastewater environments. Our composites are lightweight, high strength, corrosion/rot resistant, will not swell, take on moisture, and can be retrofitted to existing municipal and industrial water and wastewater systems.

Fiber Reinforced Polymers (FRP) are widely used in the wastewater industry because of their reliability, corrosion and abrasion resistance, affordability, and design flexibility, but the market needs are extremely diverse. FRP pipe is one of the best choices for many water supplies and wastewater applications and can save the customer money in long-term maintenance and pump-operating costs due to corrosion related friction loss.

In the wastewater industry, FRP are typically used for clarifiers, basins, tanks, reservoirs, filters (e.g. trickling, roughing, bio), scum baffles, weirs, flumes (e.g. Cutthroat, Parshall, Palmer-Bowlus), influent/effluent channels, gates, stop logs, skimmers and manholes, filter media support grids, elevated platforms and walkways, odor covers, trench and vault covers —among much else.

Typical applications include, but are not limited to, industrial and municipal wastewater supply, wastewater transportation, chemical and mechanical treatment of water. Common FRP chemical applications in wastewater and water treatment include chlorine, sodium hypochlorite, ferric chloride, hydrogen sulfide, acid waste neutralization, sludge water, desalinization, seawater intakes, corrosive water, and waste water transportation.

Key FRP Chemical Applications for Wastewater and Water Treatment

- **Chlorine**
- **Sodium Hypochlorite**
- **Ferric Chloride**
- **Hydrogen Sulfide**

Beetle's Custom FRP Products

Our customers benefit from our experience; we understand how to meet your specifications and exceed your expectations for project timing, design integration, and finished product quality. We offer unrivaled industry know-how and precision capabilities to help assist you with your specific challenges. It doesn't matter if your looking for FRP pipe, ductwork, tanks, vessels or premium custom fiberglass components - we have the technology and the know-how to execute and deliver.

Abrasion and Corrosion Resistant Pipe and Duct

Fiberglass pipe and Duct from Beetle Plastics will exactly meet your specifications and requirements, especially when you allow us to be an integral partner in your design team. We offer a range of customizable corrosion and abrasion resistant pipe that is suitable for severely corrosive industrial services.

Our filament wound and contact molded vinyl ester epoxy FRP pipe can be utilized cost-effectively in wide range of industrial applications. It can be used in these conditions, but not limited to, pressure, vacuum, supported span, and burial conditions.

Photo: FRP pipe with flanges

We offer four series of pipe and duct for corrosive and abrasive environments: 1000, 5000, 9100, and 9500-A. Each series can further be customized to meet your exact specifications and industry standards. Wide ranges of fittings are available for our pipe. Our pipe and duct are ASTM D-2996, Classification Type 1,Grade 2, Class E.

Each pipe series varies slightly with respect to performance guidelines (i.e. service environments, operating temperatures). Furthermore, our customizable pipe imparts flexibility of design and fabrication, specifically nominal wall thickness and winding angles, ultimately allowing us to create a cost-effective product for the end-user.

Customizable Pipe and Duct for Corrosive and Abrasive Environments

- **Series 1000**
- **Series 5000**
- **Series 9100**
- **Series 9500-A**

Our FRP pipe and duct are recommended for a wide range of corrosion and abrasion applications; chemical processing, wastewater, sewage treatment, water treatment, desalination, power generation **(Appendix 3 Beetle Case Study, Limestone Slurry Piping)**, salt water, brine, brackish water, mining and minerals, power generation, and oil and gas—to name a few.

Photo: Corrosion resistant, filament wound FRP pipe being removed from mandrel

Custom FRP Corrosion and Abrasion Resistant Piping and Ductwork

- Diameters from ½" to 14'
- Full vacuum and pressure services
- Filament wound or contact molded
- Wide variety of joints available
- Full range of fittings and connections
- Standard and custom FRP formulations
- Round, rectangular and elliptical ducting

Photo: Chlorine processing FRP piping, flanges and fittings

Pipe Support Systems

Beetle Plastics offers a full line of pipe supports, hangers, support anchors, and clamps for our fiberglass pipe systems. We believe it makes sense to be both a supplier of fiberglass pipe and also the support systems. Turnkey supply prevents fit up problems from occurring with multiple suppliers.

Typically our supports, hangers, support anchors, and clamps are lined with an elastomer pad, which prevents chafing and provides full bearing support. Beetle engineering will provide expert assistance in the selection of the supports for your piping system including stress flexibility analysis. Beetle also provides custom CNC plywood and fiberglass supports to meet your specific needs.

The overall design configurations of a pipe support system will be determined by many factors such as loading, temperature, vacuum, and other operating conditions. Although there are some basic guidelines used when designing FRP pipe support systems it is critical to note that each system is unique and must be treated as such. Thus, a detailed custom design is a crucial step when building a precision FRP pipe support system.

There are many considerations when designing a pipe systems and pipe support system. For example, design temperature, design stresses (i.e. tension), design pressure, material densities, thermal expansion, pressure expansion, modulus of elasticity, and thermal conductivity are crucial design considerations.

Key Functions of Pipe Support Systems

- Guide
- Anchor
- Absorb Shock
- Support a Specified Load

Types of Pipe Supports

▪Pipe Guide—directs and controls the motion of a defined span of pipe
▪Pipe Anchor—rigid support that restricts movement
▪Shock Absorber—absorbs or dissipates energy from the piping system

FRP Tanks and Vessels

Among the many products that can be fabricated from FRP are corrosion resistant tanks and vessels. Corrosion resistant FRP tanks and vessels are well known for their cost-effectiveness, long-life cycles, electrical insulation properties, high strength-to-weight ratio, dimensional stability, and their design flexibility. Furthermore, the corrosion resistance performance of FRP is exceptional when compared with traditional or common metal alloys such as stainless steel 2205 and alloy C-2706. This holds true in common chemical processing service environments—FRP performs well in hydrochloric acid and

sulfuric acids—among many others.

Table 6. FRP Corrosion Resistant Tanks and Vessels for Chemical Processing Applications

Tanks	Batching, Electrowinning, Fuel, Plating, Pickling, Processing, Recovery, Remediation, Storage, Transfer, Waste and Effluent
Vessels	Solvent Extraction Vessels, Process Reaction Vessels and Pressure Vessels

Photo: Custom corrosion resistant FRP tanker used to transport chemicals. This tank was designed to interface with trailer and included many FRP components including a man way, rollover protection, ladder, hose troughs ports, valves, and fittings.

Key Information Regarding Beetle's FRP Tanks and Vessels

- Standard and custom diameters up to 14' with heights as required
- Standard materials and custom formulations
- Engineered to meet you service requirements and specifications

When designed properly FRP can provide excellent high-temperature capabilities and solvent resistance. Depending on resin selection and other design factors, unique characteristics may be enhanced. In general, FRP withstand many acids, alkalis and oxidizing chemicals.

At Beetle all of our FRP pipe, tanks, vessels, and containers for corrosive/abrasive fluid services will have a corrosion/abrasion barrier or liner. The type and thickness of this barrier/liner and fabrication method will depend upon the specific service environment. We can customize the thickness of the corrosion/abrasion barrier to meet your requirements.

Custom FRP Tankers

Our tankers for chemical transport have evolved tremendously with the onset of shale gas drilling in the US. We offer a spectrum of FRP components and fittings that can take your design ideas to the next level and ensure that performance is optimized. We specialize in more than just providing custom FRP storage, handling, and processing equipment. We also provide proven practical solutions, custom add-ons and detailing; designed to work with your customized tanks and trucks. We offer expertise, advanced materials and processes to ensure your product is fully enhanced to be durable and meet your specific aesthetic specifications.

Beetle has extensive experience working with the storage and transport of corrosive chemicals used in the oil and gas industry. All of our custom FRP products are designed for constructability and we will work with you to ensure that our tanks interface properly with your existing truck and trailer design elements and specifications. Our 58.5" diameter transport tanks are typically made with high quality epoxy vinyl ester resins, but custom formulations are also an option.

FRP is often chosen to replace flake lined steel and tnemec lined/coated tanks, which have been susceptible to leaks presumably caused by twisting and flexing, bonding methods and thermal expansion. Our FRP tanks have been used in many shale gas-drilling applications where hauling corrosive media is essential.

Photo: FRP Tanker for corrosive fluid services designed to interface with trailer body. Custom hose trough, rollover protection, fenders, and fittings pictured.

Key Information Regarding Beetle's Custom Tankers

- Fabricated with high-quality vinyl ester resins and custom formulations
- Standard diameter of 58.5" and custom diameters available
- Corrosion resistant
- FRP is suitable for many hostile chemically corrosive environments
- Designed for constructability and will interface with existing truck and trailer design elements
- Our custom fabrication processes and finishes yield an ultra-smooth appearance

Photo: FRP tank with custom pultruded components for storage and handling of corrosive chemicals.

Table 7. Custom Components for FRP Tankers, Tanks and Vessels

FRP Tanker, Tank and Vessel Components	Man ways, Rollover Protection, Hose Troughs, Tank Saddles and Tank Support Systems, Pultruded Grating, Ladders and Custom Pultruded Product Systems That Will Interface With Existing or New Design

Hardware and Fittings	Custom Drains, Fittings, Valves, Joints and Ports, Stainless and Galvanized Fittings and Fixtures.
Aesthetic Considerations	Custom Laminate Specifications, Custom Coatings/Finishes and Custom Paint Specifications

Pultruded FRP Products

When it comes to FRP pultruded products we offer diverse products that are designed for constructability and durability. In addition a wide range of custom products Beetle also posses advanced expert capabilities.

We offer FRP equipment access work platforms and walkways for permanent or temporary use, decking and bridges, handrails, crash rails, railings, fencing, and stairways.

Photo: Custom corrosion resistant pultruded FRP decking and rails for work station.

Some of the benefits of utilizing pultruded FRP materials and products in your

design include corrosion resistance, slip-resistance, strong and lightweight ultraviolet-resistant and fire retardant. Our pultruded products are exceptional with respect to cost-effectiveness and are suitable for many industrial applications.

Key Benefits of Pultruded FRP Products

- Corrosion Resistant
- Designed for Constructability
- Slip Resistant
- High Strength-to-Weight Ratio
- Ultraviolet Resistant
- Fire and Smoke Retardant
- Non-Conductive; Will Not Spark
- Molded in Color; Reduced Maintenance Costs
- Cost-effective
- Can Be Designed in Accordance With Industry Regulations and OSHA Design Specifications

Beetle also offers pre-engineered Pultruded FRP products that can be tailored to your specifications and interface with existing or new design. Our pultruded FRP products have the potential to improve safety and access to your structures. Our simple, clean design offers quick, easy installation.

Photo: Custom FRP pultruded grating designed to interface with existing plant layout and infrastructure.

Other FRP Components

FRP Products for Industrial Ventilation

Industrial ventilation is a method of controlling worker exposure to airborne toxic chemicals or flammable vapors by exhausting contaminated air away from the work area and replacing it with clean air. This is one option to control employee exposure to air contaminants in the workplace.

Industrial ventilation is typically used to remove fumes, solvent vapors, oil mists, or dusts/airborne debris from a work location and exhaust these contaminants to filtration or outdoors. We offer fully customizable ductwork that has been successfully employed in a variety of demanding industrial applications from chemical processing to power generation. Among much else, Beetle can fabricate chemical duct systems, fume duct, transport duct, and odor control duct, as well as, many other components such as, air strippers, and mist eliminators. We have the capabilities to deliver custom fan system components such as inlet bell/cone, outlet cone, impellers, fan casing/shroud, nose spinner/outlet nose spinner, hoods, and louvers.

Table 8. Custom FRP components for industrial ventilation and fan systems

Duct	Chemical Duct Systems, Fume Duct, Transport Duct, Odor Control Duct
Fan System Components	Louvers, Hoods, Ridge vents, Inlet Bell/Cone, Outlet Cone, Impellers, Fan Casing and Shroud, Nose Spinner and Outlet Nose Spinner
Other Components	Air Strippers and Mist Eliminators

At Beetle we have expert design professionals and the ability to offer high-quality, industrial turnkey solutions. We'll work with you to address your specific ventilation needs and create a custom constructible fiberglass product.

FRP Products for Power Generation

Beetle's experienced cooling tower engineering and design group can offer you the best value option for your particular application, whether it is one of our pre-engineered cooling towers, or a custom designed solution. Our team will work with you through the design, budgeting, planning, and installation of your cooling tower project to make sure you get the best job for the best value.

We have unmatched design intelligence that can provide product development and support. At Beetle we can create new products as well as assist you with incremental improvements. We manufacture and supply components to over 85 other cooling tower companies and contractors in the U.S. and more than 110 around the world.

Leverage our strengths such as, single source design-build capabilities of new cooling tower construction or reconstruction, thermal upgrade, emergency repair, custom components, and replacement parts.

Our composite products are electromagnetically transparent, nonconductive and corrosion resistant. Our composites are perfect for use in cooling towers and discharge areas, as well as, around transmission structures, distribution equipment, in storage, and containment areas.

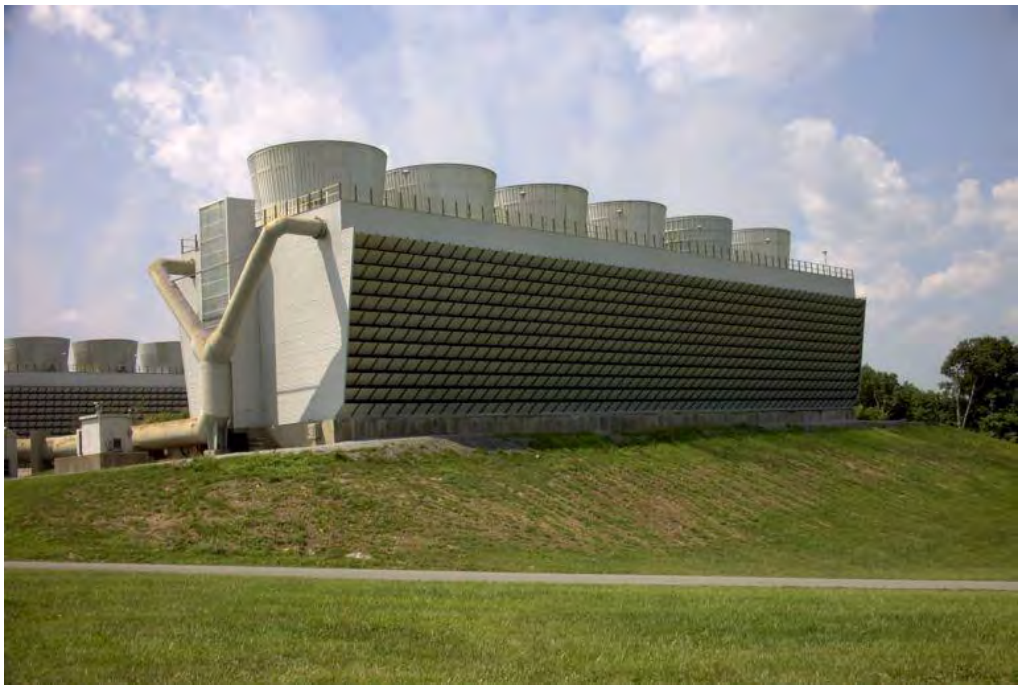


Photo: FRP Cooling Tower

Cooling Tower Applications

We offer solutions for counterflow towers, crossflow towers, natural-draft towers, and ethanol towers. Similarly, we offer a wide range of custom components including, fan stacks, louvers, fan decking, water distribution systems, and fill and drift eliminators. Common applications include cooling the circulating water used in oil refineries, petrochemical and other chemical plants, nuclear power, thermal power stations and HVAC systems for cooling buildings.

In addition, we offer custom FRP structural components including: platforms, walkways, stairways, decking, platforms and railings. All of these products can be manufactured to satisfy your industry regulations and specifications. Our product offerings are diverse; we also offer galvanized cast iron and stainless steel hardware/components.

Photo: FRP cooling tower application

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Beetle PLASTICS

Case Study
April 2013

Custom FRP.

1 For this project Beetle manufactured pipe with diameters ranging from ½" to 30" and lengths ranging from 10 ft to 30 ft. Similarly, over 2000 linear feet of pipe was installed during this job.

2 We have the capacity, capabilities, and technical know-how to provide custom FRP components with precision-tailored to your needs. Our FRP products are designed for constructability and provide end-users with cost-effective solutions. We have a rich history in fiberglass and expertise that is unrivaled—we know how to execute and deliver.

Contact Molded Fiberglass Pipes and Fittings for a Chlorine Processing Plant

Opportunity: Customer requested high quality FRP pipes and fittings for a chlorine processing facility. The material solution needed to be suitable for handling wet chlorine gas and other corrosive media. This was an international job and required expertise and understanding of industry standards.

Solution: Beetle designed and manufactured custom corrosion resistant FRP pipes, fittings, pipe spools, and stock pipe components that interfaced into the customer's existing plant infrastructure. Beetle also provided technical support during installation and inspection.

Comments: Beetle's ongoing relationship with this customer includes a wide range of services; we provided on-site inspections, technical support and fiberglass design support. Similarly, there is a simultaneous effort to customize the customer's laminate design to better meet their processing needs in the most cost-effective fashion.

Appendix 2.

Common FRP Design Considerations List

- All chemicals to which the equipment will be exposed: feedstocks, intermediates, products and by-products, waste materials, and cleaning chemicals
- Normal operating concentrations of chemicals, maximum and minimum concentrations (including trace amounts)
- pH range of the system
- Normal operating temperatures of the equipment, including maximum and minimum temperatures. In addition duration of normal, maximum and upset operating temperatures.
- Abrasion resistance and/or agitation requirements
- Equipment size
- Manufacturing methods
- Flame retardant and smoke retardant requirements
- Thermal insulation requirements
- Vacuum Specifications

Beetle PLASTICS

Case Study
June 2013

Westar Energy.

Westar Uses Limestone Slurry Piping to Reduce Plant Down Time

Custom FRP.

1 Westar Energy is the largest electric power producer in Kansas. From their various "energy centers" they produce electricity from wind, coal, nuclear, natural gas and landfill gas.

2 After some time in operation, it was determined that there were areas of "high wear" in one of the 8 inch fiberglass pipe lines at some of the elbow locations. In order to replace the worn elbows, it required the shutting down of the system, draining of the lines, and time for fiberglass service crews to cut out and replace the elbow sections with butt

Opportunity: Three years ago, in one of Westar's coal-fired centers, they refurbished a Flue Gas Desulfurization (FGD) system. The purpose of this system is to remove the sulfur dioxide (SO2) from the flue gas emissions. Limestone slurry is a product used in the flue gas emissions process to remove SO2. The limestone is abrasive and requires an abrasive resistant piping system. Abrasion resistant fiberglass pipe was chosen to move the limestone slurry within the system.

Solution: The Beetle Plastics LLC Technical Services Group, along with our sales representative Steve Furman of Tompkins, Furman & Associates, worked with Westar personnel at the site to understand the problem and to develop a design change to reduce their downtime due to these "high wear" elbows. The end design was to replace the "butt and wrap" fiberglass pipe elbows with flanged elbow connections. This design allows quick change out of the elbows when the wear issues occur. These change outs can be done by plant personnel without the time and expense for outside fiberglass field service crews, thus reducing cost and shortening the down time for the replacements.

Comments: The cost to shut down a power plant for an emergency repair is very high, both in the cost of power generation lost and manpower to make the repair. The solution developed through the cooperation between the personnel at Beetle, Westar and Tompkins, Furman will help to reduce future pipe maintenance costs in this FGD system and assure continued supply of electric power to Westar's many customers.

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