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Isophthalic and Vinyl Ester Resins for New Corrosion Infrastructure Applications

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ABSTRACT

With the growth of fiber reinforced composites in the Asian markets, the demand is high for consistent and predicable polyester resin and vinyl ester resin systems. Quality infrastructure composite experience over the last 30 years has provided the stepping stones for new corrosion infrastructure applications that should be adaptable to the Asian market, and indeed, the global market. Fiberglass reinforced underground gasoline storage tanks have been used successfully for the last quarter century. Power station intake and output pipes, some as large as 4.9 meters in diameter, continue to perform without problems. More recently developed composite products include short span bridges for handling regular road traffic, pedestrian bridges, sewer liners and water covers for water treatment plants.

INTRODUCTION

Fiberglass reinforced Vipel® isophthalic and vinyl ester resin composites have achieved a remarkable degree of commercial acceptance in a variety of infrastructure applications. Initially, isophthalic resins such as Vipel® F701 and the resilient version Vipel® F737, were widely used, but lately vinyl esters such as Vipel® F016 have played an important role.

HISTORIC SUCCESSES

Two noteworthy infrastructure successes have been underground gasoline storage tanks and power plant water pipes.

Underground Gasoline Storage Tanks

The first recorded underground gasoline storage tank was put into service on May 11, 1963 in Chicago, Illinois, USA. This tank was fabricated by laying resin impregnated Owens Corning fiberglass woven roving and chopped strand mat on a mandrel.

The composite semi cylinders, along with foam-filled end caps, were bonded together with composite lap joints. The tank was then placed in service to hold gasoline. Twenty-five years later, it was dug up to determine its condition. There were no signs of structural distress, chemical attack or leakage into the soil. As you can see, it was strong enough to be lifted from the hole by a crane using the center outlet pipe as the only source of support. It was one of about 60 tanks developed in the mid-1960's by Amoco Chemical Company in conjunction with Amoco Oil Company. The Oil Company was looking for an alternative to steel tanks, which were prone to leakage due to corrosion. AMOCO specified that the resin be made according to their SG-10 Isophthalic experimental product. This formulation served as the basis for the AOC's Vipel® F701 resin.

POWER PLANT WATER PIPES

In 1978, the Jacksonville Electric Authority in Florida, USA required a pipe to distribute water from their power plant into the Atlantic Ocean. The one end has been ground in preparation for a butt and strap joint, which was required at a few strategic locations on this project. The pipe connections were normally double O-ring, bell and spigot joints. An Owens Corning fiberglass reinforced pipe using AOC's Vipel® F737, a resilient Isophthalic acid resin, was chosen in this case because of its corrosion resistance to seawater and its impact resistance. The entire installation was subaqueous with each length of pipe installed and then backfilled by cranes and divers operating from barges. To disperse the warm water over a larger area, the 4.9-meter pipe was connected to two, 3-meter diameter legs, each 46 meters long, by means of a large reducing "Y" joint which is shown here.

When the Niagara Mohawk Power Corporation, in New York state, USA, replaced two leaking, wooden pennstalk pipes which supplied water to the power generating stations, Owens Corning fiberglass reinforced pipe was chosen because:

1) Of its lightweight.
2) The ease of installation.
3) Leaks were eliminated.
4) The flow rate of the water was increased.
5) It was also the most cost effective.

The first project in 1979 was a bell and spigot pipe approximately 1,500 meters long by 3 meters in diameter, manufactured in 18-meter lengths. A special transportation rig was designed to facilitate loading, unloading and transportation. The rig was positioned inside the pipe. Then the pipe was transported by truck to the site.

The second Niagara Mohawk Power Corporation pipe completed in 1980 was a similar style, 2380 meters long by 3.7 meters in diameter.

The pipes made in these three major projects were manufactured by ZCL Composites, Inc. using Owens Corning reinforcements and AOC's Vipel® F737 resilient isophthalic polyester resin.

CURRENT SUCCESSES

1) Underground Gasoline Storage Tanks

Underground gasoline storage tanks continue to be built with Owens Corning reinforcements and AOC's Vipel® F701 isophthalic resin. The design and construction of today's composite tanks are more sophisticated. For example, leak detection devices inserted between double walls make them environmentally friendly. To date, at least
150,000,000 kilograms of resin have been used to manufacture underground gasoline storage tanks. Both Fluid Containment, as shown in this slide, and ZCL Composites manufacture underground gasoline storage tanks with Owens Corning reinforcements and AOC's Vipel® F701 isophthalic polyester resin.

AOC is currently taking a proactive position by developing a new generation of resins with improved resistance to alcohol blended fuels.

2) Pipes

Owens Corning reinforcements and AOC's Vipel® F737 continue to be the workhorse for infrastructure pipe applications. For example, from this manufacturing site Owens Corning is completing the delivery of 250 kilometers of high pressure fiberglass reinforced pipe between 1 meter and 1.4 meter in diameter, for a line which stretches from the Sashe River in Botswana's north-east to its thirsty capital, Gaborone, located in the south of the country. It is claimed to be one of the biggest glass fiber reinforced projects under construction anywhere in the world. Materials of manufacture include 14,000 tons each, of Owens Corning glass fiber and AOC's Vipel® F737 polyester resin and 5,000 tons of sand.

Two of the decisive factors behind Owens Corning's successful bid for the major share of the 360 kilometer North-South Carrier pipeline were the competitive price and the performance value of fiberglass reinforced pipe compared to traditional pipe materials. Other factors were the excellent resistance to chemical and biological attack, the ease of manufacture and its abrasion resistance. In addition, the capital expense was less to set up a plant to manufacture fiberglass-reinforced pipe than one to manufacture traditional materials. This is one of the two mandrels that are used to manufacture the pipe. Note that the production area required is small. The next five slides show the pipe from the quality control test phase to its final installation. This is a storage area for pipe. The pipe is easily lifted with light equipment. Pipe is lowered into the ditch, and then joined together. It is expected that this project will open up new opportunities for the use of fiberglass reinforced pipe for other water transfer systems around the world. AOC's Vipel® F737 resin was used for the first major portion of this line and a newly developed resin was used to finish the project.

3) Sewer Liner Rehabilitation

AOC's isophthalic family of resins are used in growing quantities to rehabilitate underground or inaccessible concrete, clay, brick and steel sewers that have failed or are failing. Pipe failure can be caused by anything from chemical attack, to ground movement, to traffic loading, to leaking joints. Instuform Technologies Inc. has developed a method to reconstruct a sewer pipe by inserting a new structural pipe within the original pipe, thereby greatly extending its life. Because no excavating is required, thousands of kilometers of pipe have been repaired without the disruption caused by replacement, in a much shorter time and with significant cost savings. Here we see how Insituform rehabilitates the sewers:

a) This is the felt reinforcement.
b) The felt is impregnated with resin.
c) The impregnated sock is beginning to be inverted into a damaged sewer line.
d) The inversion process continues.
e) Hot water is recirculated in the inside of the inverted sock in order to cure the resin.
f) Laterals are cut out with a remote cutting device
g) This is the final reconstructed pipe.

4) Bridge Construction

One of the more novel examples of the use of fiberglass reinforced composites in infrastructure is the building of bridges for regular road traffic. In many locations in the United States, there is a need to quickly replace bridges about 7 meters long that have been washed out by floods. A recent successful application of this has been the replacement of a bridge at No Name Creek in Kansas, in November 1996 loader laden with wet sand on a flat bed truck. In this case, AOC's Vipel® F457 isophthalic/PET resin was used to manufacture the structural portion composed of a fiberglass reinforced honeycomb sandwich construction. The initial phase of the honeycomb construction is shown here. AOC's vinyl ester Vipel® F016 resin was used to manufacture a laminate that bonded the sandwich construction components together. The bridge was constructed with three panels that were each 7.1 meters long, 2.7 meters wide and 0.56 meters thick. The span on the bridge was 6.4 meters wide.

Before the bridge was installed, it was tested off site by driving cross it a large front-end with this 28,200-kilogram weight at the center of the bridge, the deflection was less than 0.95 centimeters. Here is one of the sections being installed. Note that the guardrail is already prefabricated onto the bridge section. The bridge is in service. A videotape is available that shows in detail the manufacturing operation and installation. As a result of this pioneering effort, Kansas Structural Composites won the Owens-Corning Counter Poise award at the 1997 Composites Institute Conference in Nashville, Tennessee for best overall application of reinforced plastic composites for 1996. Several pedestrian bridges have been built in remote areas because of the inherent corrosion resistance and lightweight features of fiberglass reinforced isophthalic resin composites.

5) Water Treatment Plants

A practical application for fiberglass reinforced composites is water covers for water treatment plants. Isophthalic resins are used widely because of their lightweight, high strength and their corrosion resistance. These are aerator covers.

CONCLUSION

For several years, AOC and its parent companies, The Alpha Corporation and Owens-Corning, have played an instrumental part in developing isophthalic and vinyl ester resins for infrastructure applications. A tripartite agreement in 1992 between AOC, BASF Structural Resins and Takeda has enhanced this strong position. These successes are being used to solve corrosion and logistics problems in the infrastructure where traditional materials have proven inadequate.

REFERENCE

AMOCO Bulletin IP-88d.

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