By Bob Hummel

FRP Linings in Above-Ground Storage Tanks: *How Strong Are They?*

Chemicals can be severely corrosive to above-ground metal storage tanks, resulting in possible leaks. The average corrosion rate of some carbon-steel storage tanks in certain services at ambient temperatures is more than 1 mil per year, with leaks developing in as few as five years. These leaks result in costs for both tank repair and possible environmental penalties.

Tank corrosion sometimes increases when a layer of water containing soluble salts and chlorides settles to the bottom. These compounds are highly corrosive in themselves, and they can generate a strong electrolyte that further promotes corrosion from within. There can be a problem with external tank corrosion as well. The bottoms of above-ground storage tanks are susceptible to corrosion, especially if the tanks are close to salt water or subject to stray electrical currents in the soil.

If an above-ground tank bottom is corroding, it must either be replaced or coated with a thick-film, fiberglass reinforced plastic (FRP) lining with a 60 to 65 mil dry film thickness. Since replacing a tank bottom can be costly and time-consuming, FRP linings have become a popular alternative for tank bottom repair.

FRP Lining Installation

The recent trend has municipalities shifting away from replacing tank bottoms and toward the application of FRP lining systems where recommended. Installing a lining system means applying a primer, putty, catalyzed resin with a glass mat and a sealcoat. The tank must be dry and the surface properly prepared. The entire process is quicker and less expensive than replacing an entire tank bottom.

Thick-film FRP linings are considered secondary bottoms that are bonded tightly to the storage tank. When properly selected and applied, they prevent leakage

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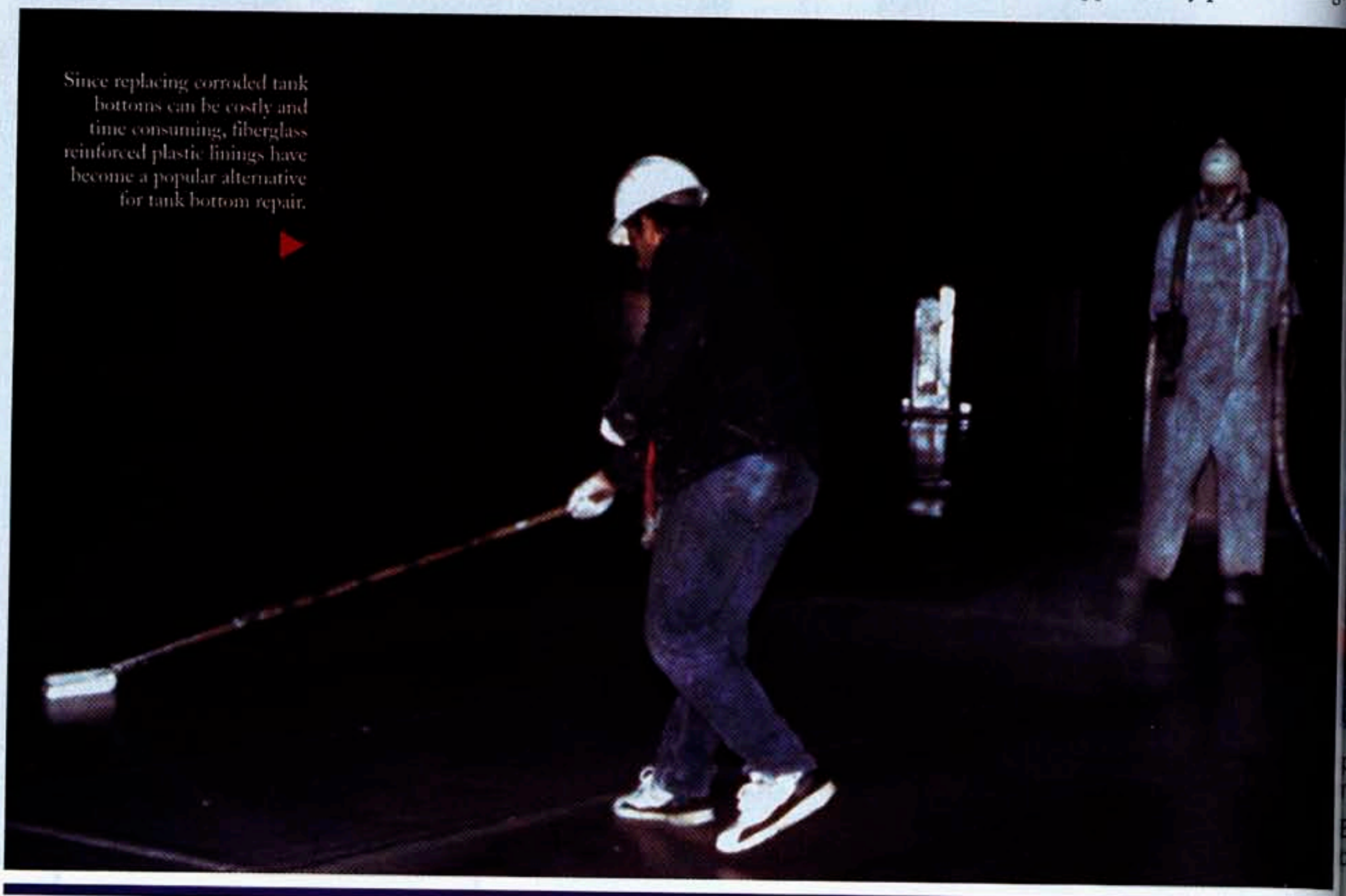

due to internal corrosion for 10 to 20 years. If the supporting steel bottom is perforated, these linings also can help minimize the problem of exterior corrosion by providing enough strength to bridge small perforations. Even if severe corrosion is present on the outside, it is possible to apply a double layer of the laminate for a total thickness of 110 to 120 mils. (Linings of less than 20 mils dry film thickness will not protect against leakage from outside corrosion. They are recommended only for relatively new tanks with no internal pitting and underside corrosion.)

FRP Development

Introduced in the mid-1950s, the first FRP laminates were orthophthalic polyesters that bridged gaps caused by underside corrosion and were thought to provide protection from internal corrosion as well. However, in the early 1960s, it was found that isophthalic polyester resins were better able to withstand aggressive conditions. Vinyl ester resins were introduced in the middle 1960s and performed very well, but their expense meant that they were used only when high performance was needed. Today, many FRP linings consist of epoxy novolac residents in a vinyl ester backbone.

As with any repair method, FRP linings have advantages and disadvantages.

Advantages

- FRP systems can bridge holes up to 8″ diameter, with double laminates withstanding 82 psi and single laminates 37 psi.
- FRP linings with vinyl ester resin systems can resist numerous corrosive cargoes at elevated temperatures.
- FRP linings cost less than replacing existing steel tank bottoms.
- Since FRP linings can be installed more quickly, they minimize down time, so the tank can be placed back into service much sooner than it could with conventional tank linings or bottom replacement with new steel.
- In many installations, FRP linings have a 35-plus year history of service.

Disadvantages

- When pigmented gel coats are used, it is not possible to see the steel bottom to determine the existence or extent of bottom-side corrosion. However, new technology and high power magnets can now let operators scan the thick laminates to gather accurate information about corrosion taking place beneath the steel bottom.
- Applicators must be aware of proper installation procedures and the importance of clean, contaminant-free substrates before application.
- While cyclic loading may affect the long-term ability of FRP linings to bridge a large, clear opening, the extent of its effect is not yet fully known.

Standing Up to Pressure

There have been many articles written about FRP laminates that discuss the pros and cons of their use as an alternative to steel tank bottom replacement. One case history described a leaky 211-foot-diameter tank that had an FRP laminate installed in 1985. In mid-1995, a leak developed in its sump area, caused by bottom-side corrosion. Two holes had been created, each approximately one foot in diameter. However, it was determined that the FRP laminate had not failed. In fact, it was only the FRP laminate that had been containing the contents of the tank and it did so until hydraulic pressure finally caused the laminate to rupture.

How much hydraulic pressure can FRP laminate systems withstand? One physical pressure test took place in a water-filled chamber that could be steam heated through a pipe loop until it reached 140° F. Eight plates of 12″ × 1½″ × 4″ steel were fabricated, with a set of holes cut from the middle of each of four plates to represent corrosion pits. The holes (½″, 1½″, 4″ and 8″ in diameter) were filled with melted wax, with an isophthalic polyester resin laminate installed on top. A single lami-

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