Improving the Life of Tanks and Liners

Maintenance is a controllable expense, but only for the proactive.

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With U.S. plants continually aging, downtime is on the rise. Facilities can lose as much as 20 percent of production capacity from downtime, and it’s difficult to accurately project these financial setbacks. Without precise numbers, decision makers often underestimate costs and, therefore, can’t be expected to make informed repair or replacement decisions, which should take into consideration not only downtime, but total cost of ownership, including maintenance and expected service life.

Tank maintenance is a controllable expense, but only for the proactive. While it may be wise to rely on redundant equipment, such as spare tanks, to maintain production reliability, it’s best to have a long-lasting, affordable solution. Although some finishers might rely on a supplier’s guarantee, the ability to have a long-lasting, affordable solution is a must account for it. Weaker materials can be accommodated with increased wall thickness. In addition, some tanks may be successfully protected with coatings, but linings or rigid plastic liners offer a much thicker barrier.

The most important property of any coating or lining system is adhesion to the substrate. For this, proper surface preparation is critical. When applied to concrete, it is important to check for moisture content and moisture vapor transmission. The surface must be free from contaminants and laitance, loosely adhering concrete and dust, and oil and grease (which unfortunately can’t be removed by abrasive blasting alone).

Lining Materials

Vinyl, or flexible polyvinyl chloride (PVC), is a mainstay of the industry because it bonds well and offers long-term thermoplastic weld repairability. Although vinyl is flexible and tough, damage can occur where parts or equipment repeatedly contact the liner surface, including abrasion, cuts, extreme impact and so on. Bumpers, or even acid bricks, may be used to protect the liner in those situations.

Rubber linings have long been used in industry. These linings are installed by applying sheets of rubber compound to the tank surfaces and then vulcanizing in place, usually by application of steam heat under pressure in an autoclave. The lining can be repaired by similar application of heat or chemical curing agents, but the cumbersome curing conditions are limiting and most users have switched to synthetics.

Although lead-lined wooden tanks were once common, especially for acids, they are now rare because of repair and toxicity issues.

Choices on the Market

Tank liners are often thought to be a commodity—buyers tend to purchase on price, overlooking maintenance and downtime costs. Exercise caution with lowball bids based on use of inferior materials and/or methods.

Liner technology continues to move toward a number of goals: seamless linings, easier detection of leaks, increased service life, monitoring systems, lower cost and improved shock resistance.

Thermal expansion stresses the plastic, so tank design must account for it. Weaker materials can be accommodated with increased wall thickness. In addition, some tanks may be successfully protected with coatings, but linings or rigid plastic liners offer a much thicker barrier.

Polypropylene (PPL) is an economical, yet flammable, material. Of thirty plastics tested, PPL was rated worst as a fire hazard. Once ignited, it burns vigorously and up to three times hotter than wood or paper. Temperatures up to 2,000°F are reached—sufficient to weaken steel and collapse buildings.

Homopolymer PPL is also brittle and may crack upon impact, while copolymer PPL is more resistant to cracking, but far more difficult to weld. Rigid PVC offers excellent fire properties. It is slow to ignite, slow to spread, and when the flame source is removed, PVC ceases to burn.

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Type II PVC offers very high impact resistance. Chlorinated polyvinyl chloride (CPVC) is the next step up in PVC. It can be used at higher temperatures and higher pressures than PVC. Due to its higher chloride content, it also offers more fire resistance. It should be noted, however, that CPVC has a tighter temperature window for welding and only a few experienced fabricators do extrusion welding with CPVC.

Polyvinylidene fluoride (PVDF), a fluoropolymer, offers resistance to a wider range of materials including organic solvents, and can be used at higher temperatures. PVDF tanks are relatively high cost. Fiberglass tanks (or more correctly, tanks constructed of fiberglass-reinforced composites) can be suitable when properly matched to the materials to be contained. Fiber-reinforced plastic (FRP) is brittle and must be maintained by periodically applying topcoats—another source of downtime.

Steel tanks with linings typically offer longer service life with fewer problems.

**Tank Linings**

Lined tanks are widely used in the finishing industry—especially for corrosives. The lining protects the tank from corrosion and the contents from contamination, while the substrate provides structural integrity. In electroplating, the lining also provides electrical insulation.

For the best results, the steel tank is blasted, or the concrete etched, before the lining is bonded. Bonding prevents rusting and avoids stress crack failures from wrinkles in drop-in bag liners. Plastic welding then seals the seams and corners.

Concerns regarding bonded vinyl linings include: repairs that require outside services, disposal of used lining material, leaks from pinholes and weld failure, separation of the bonded liner from the substrate, old linings that have failed, and weld failure, separation and the contents from contamination, while the substrate provides structural integrity.

The industry continues to develop to provide better performance. Case in point: Newly deployed extrusion welding is used to seal seams and infuse molten material into the steel corners, resulting in much less cracking and more tolerant of stresses. In addition, if a leak occurs, solution does not flow behind voids or channels present with conventional corner and seam strip welding.

Another improvement is the use of radio frequency (RF) machine welding to make full panels for the walls and bottom. If the tank is large, subpanels are joined by skived edges with overlapping extrusion welds. The goal is to eliminate hand welds with seam strips in immersion service.

Not all vinyl is created equal. Thicker lining will outperform thinner lining and is cost effective long term. A high performance grade is available when the application (temperature and chemistry) requires it.

**Bag Liners**

Bag liners, a low-cost solution to a leaking tank, are fabricated from flexible plastics with RF-welded seams. The liner relieves the tank substrate to support the load and must be fitted carefully to avoid wrinkling or stretching. There are numerous drawbacks. Stress points can cause leaks, which can be difficult to find and repair. And the liner may float and move into the working area. In addition, inspection of steel and weld integrity may not occur, and if rusting behind the liner isn’t inhibited, corrosion from previous leaks may continue unabated. Thus, experience indicates that bag liners are not a substitute for bonded linings and should be considered a temporary remedy.

**Rigid Drop-In Liners**

Rigid liners can be fabricated from heavier plastic sheets, typically from PVC, CPVC or PVDF. (Some suppliers assemble “stick-built” liners within the tank, but this can cause weak surface welds. In-place assembly can result in buckling, stress cracking and cracked welds.) Assemble in the shop enables the use of plastic welding with 90° thermally-formed, machine-bent, rounded corners with machine-pressure butt-welded side walls for strength. The sidewall/bottom joint is a routed mechanical lock-in with machine extrusion welding. And molded corner inserts enable continuous extrusion welding in the problematic inner corners.

To provide maximum containment and double protection a rigid PVC drop-in liner may include bonded vinyl on either the inside or outside of the rigid shell. A conductive bonding adhesive enables alternative current (AC) spark testing.

Liners must be undersized to enable thermal expansion and the walls must be supported in void areas to accommodate the load of a full tank. A bumper system can be placed under the liner for shock absorption. Properly made rigid liners provide excellent service life and are more resistant to mechanical damage.

**Leak Detection**

In an era of strict attention to the environment, especially groundwater contamination, early detection of leaks is important. In new construction, double bottom tanks and/or secondary containment are now common. Prompt leak detection enables repair before damage becomes extensive.

Dyelectric testing, commonly called “spark testing,” is traditionally used to detect pinholes in tank linings. Leaks are found by a point source of voltage applied across the liner. Sparking occurs when a gap in the liner enables the passage of current to the ground. One limitation is that heat from the arc can burn holes in the tank liner. In addition, the tank must be dry to avoid inaccurate readings.

Leakage detection systems are more reliable for large, new or recently rehabilitated tanks. Such methods can be expensive, however. For thin coatings, a battery-operated wet sponge tester is grounded to the substrate and an alarm sounds if a circuit is created, such as when moisture finds its way through a pinhole or hole. Although effective, this method is time consuming and requires wetting the entire tank surface section by section. For thicker plastic or rubber linings, high-voltage AC spark testers are commonly used. Small, handheld models may not be calibrated for the liner material and its thickness, relying on the skill of the operator to rapidly test for leaks without doing damage. Modern DC testers can automatically adjust the test voltage to the liner and signal leaks with alarms and by sparking. Neuer models reduce voltage as soon as the circuit is created to minimize damage.

Many believe spark testing doesn’t work on lined concrete tanks. However, DC spark testing is effective. A nail driven into the concrete exterior serves as the ground contact, while a second nail contact signals sufficient moisture to permit testing.

New technology can detect leaks electronically without draining the tank, greatly reducing the time needed to check for leaks and making monitoring less of a hassle.

Cathodic protection is a proven technology for guarding ductile pipelines and steel tanks, and has been used to protect lined electroplating tanks. By applying DC potential, a pinhole leak is plated again and again, which can result in a sizeable deposit of metal, sometimes called a “tree,” which can create plating problems and eventually get in the way of the parts, although plating exposed steel may be preferable to a corroded steel leak.

Modern instrumentation can find this liner breach and enable repair on a scheduled basis.

**Innovation**

An example of a design improvement is the use of PTFE skirting to extend the service life in vinyl lined tanks for hard chromium plating. The skirting protects from cracking usually observed at the air interface.

Another innovation is a concrete anchoring technique using an inverted V-notch cut into the concrete. Linetings can be secured by infusing weld plastic into the notch, essentially welding the lining to the concrete.

New techniques have also been developed to detect leaks in double-bottom tanks. By filling the outer tank with water to a height of about 5 centimeters above the bottom of the inner tank, leaks are detected by measuring current flow in the water. The water also prevents an inner tank leak from rising acid into an air void that wants to be filled. Thanks to the laws of fluid dynamics, the water provides another level of risk mitigation.

The ideal tank supplier works as a partner, is up-to-date on recent developments, has experience to assist in material selection and is prepared to offer service for the life of your tank. Look for advances that can improve your results and your bottom line.

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