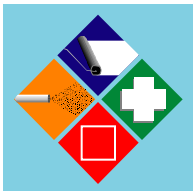
Applying Liquid Tank Linings



This month's installment of the Applicator Training Bulletin was written by Lloyd Smith, Ph.D., Corrosion Control Consultants & Labs, Inc., Glen Burnie, MD, USA.

Tank linings are applied to the inside of storage vessels, process vessels, and transportation vessels (e.g., rail cars, ships, and semi-trailers) to prevent corrosion and, in many cases, to protect the tank contents from contamination by corrosion products of the substrate or by any constituent in the lining. Proper application is critical to lining performance. Steel or concrete tanks or storage vessels usually require a protective barrier. This can be a liquid-applied coating system or a fibre-reinforced mat system. (See the December 2001 ATB.) This ATB will focus on lining steel tanks and vessels with liquid coatings.

Lining Materials

Lining selection is normally not the job of the applicator. Some factors that must be considered are the chemicals being stored and their corrosion rates, operating temperature (and pressure in some reaction vessels), abrasion caused by agitation of a solution containing high solids, and even cleaning chemicals and procedures.

Tank lining materials can consist of elastomers, organic resins, cementitious products, inorganic masonry, and metallics. Elastomers are materials such as natural rubber, synthetic rubbers, chlorinated rubbers, and nitrile rubbers. They are generally applied as sheet material, but some are available as liquid coatings. The common organic resin systems are based on phenolics, epoxies, polyesters, vinyl esters, and polyurethanes. These may contain reinforcing pigments such as silica sand; carbon; or other inorganic materials, including fibreglass sheet reinforcement (November 2001 ATB). Cementitious linings are spray- or trowel-applied on the surface. Inorganic masonry linings consist of bricks used with an organic resin membrane. Metallics include zinc, aluminium, nickel, stainless steels, and copper-based alloys that are applied by hot-dipping, electroplating, chemical plating, or thermal spraying.

With so many different types of materials available, it is imperative that the applicator read and understand the application instructions in the product data sheet.

Surface Preparation

Surface preparation is as critical to the lining process as it is to coating application. The main concerns are cleanliness and anchor profile. White Metal blast cleaning (SSPC-SP 5) is preferred, although sometimes Near-White (SSPC-SP 10) is acceptable. Check the specification and product data sheet for the minimum level of cleanliness. Low-dusting and low-fragmenting abrasives are preferred. Low-dusting abrasives will make it easier for the worker to see and to clean the surface. Low-fragmenting abrasives will minimise the number of particle embedments, which can cause pinholes or thin spots in the liner. The surface should be cleaned of surface preparation debris, especially dust. Even if blow down is used, it is good practice to vacuum the surface as a final cleaning because dust blown off one part of the tank can land on an already-cleaned surface.

Chemical cleanliness is also important. Salts or other ionic contaminants on the surface can accelerate corrosion. Coatings are semi-permeable membranes. If differences exist in salt concentrations on the opposite sides of semi-permeable membranes, water will be forced through the membrane from the side with the lowest salt concentration to the side with the highest salt concentration. This phenomenon is referred to as osmosis.

And finally, oil and grease must be removed before surface preparation, especially on tanks that hold oily or greasy materials. If cutting oils were used, they would be present on the surface in new tanks. Relining projects on tanks that held oily or greasy products will require the entire surface to be solvent cleaned. Oily or greasy materials on the existing lining surface could be driven into the steel by abrasive blasting or be absorbed into the rust layer.

Surface profile is also important. The actual surface profile height required depends on whether a thin-film or thick-film system is being applied. Thicker systems need a higher surface profile. Consult the product data sheet for the specific range for the product being applied.

Attention must be paid to surface preparation of welds, seams, brackets and other items attached to the tank. All weld spatter needs to be removed. The welds may need to be ground smooth, ground smooth and flush, or ground smooth and blended into the plate surface.[1] The end condition of the weld is an engineering decision based on the corrosiveness of the material being stored and must be addressed in the specification. The surface of the weld area must be blast cleaned to the specified grade and anchor profile after grinding. It is quicker to prepare the welds before blasting on new tanks. On relining projects, the existing coating must first be removed, weld area repairs must

be performed, and then the area must be reblasted.

Coating Application

Some lining materials have very narrow storage temperature requirements and a relatively short shelf life, i.e., one to two months. So check the product data sheet for storage requirements. A heated or air-conditioned storage area may be needed.

This riveted fuel oil tank was sealed with an elastomeric urethane to prevent leaking. Photos courtesy of Carboline

Next, check the mixing and application instructions. Most linings are multi-component paints that come in two or more cans. Each component must be mixed and then the materials mixed in the proper order of addition. Add all the materials in the cans so that the final, cured film has its intended properties.

Pot life can be very short for some lining materials, e.g., as low as 10 or 15 minutes, and is reduced at higher temperatures. Know the pot life for the material being used and plan the mixing and application accordingly. There may be an induction time, i.e., the amount of time that the coating must pre-react after mixing the components together before it can be applied. This should also be investigated before application to work out the timing sequence.

Most organic resin systems used as linings can be applied by brush, roller, or spray. Some are applied with trowels while others react so quickly that they are applied by plural-component spray. Spray application (either conventional or airless as indicated on the product data sheet) is preferred for liquid lining materials with a reasonable pot life. This method gives the most uniform application. Roller application is sometimes acceptable and is used where spraying cannot be tolerated. Seams will have to be brushed when applying the coating by roller, or in lining repairs where only small areas are involved. It may not be possible to apply the lining to the specified film thickness in one coat when brushing and rolling because liquid coatings tend to flow when they are manually "worked." You may need to plan for two applications per coat.

Welds and seams may require special treatment. Stripe coating is usually specified for welds. It is best to work the material into the surface with a brush. Older, riveted tanks may require a seam sealer to stop leaks that have developed from movement of the tank's shell plates.

Most lining systems are designed with multiple layers of material—two or more coats of the same material, or a different material for each coat. It is good painting practice, especially with multiple coats of the same material, to have each coat tinted or supplied in a different color. This will help the applicator see the areas not yet coated.

Attention must be paid to recoat intervals. Lining materials are formulated for chemical resistance. As such, especially with highly corrosive materials, the lining material is designed to cross-link very densely and to become chemical resistant. This dense chemical structure affects the ability of another coat of material to stick to it. Therefore, the material may have both a minimum and maximum recoat interval. Recoat intervals are temperature-dependent. Consult the product data sheet or the lining material manufacturer to determine the minimum and maximum recoat interval for the temperature range at which the work is being performed. Plan the work so that the next coat of material is applied within the allowable recoat interval.

Thickness is critical. Too thin a lining can fail. Too thick a lining can lengthen the time of final curing or affect proper film formation. Solvents retained in the film will eventually leach out and contaminate the tank contents or degrade the lining.

In applications such as rail cars, semi-trailers, and smaller tanks, solvent evaporation can be accelerated by heating the surface between applications. This should be done with indirect-fired heaters or radiant heaters. Sometimes just heating the outer surface to raise the steel temperature will be sufficient The tanks will need to be ventilated to remove the solvents given off.

Special attention must be paid to the floors or bottoms. Paint particles dry as they fall and do not adhere well to the surface. Coating over them will result in early coating failure. Coating the floor or bottom first is technically the best solution, but impractical in most cases. Therefore, floors should be covered when doing the overheads and walls. This applies to every coat, not just the primer or first coat.

Scheduling Work

Small items such as rail cars, semi-trailers, and small tanks usually have each layer of the liner applied as one step. Large tanks can be lined by individual sections or as one section. When working by section, the normal technique is to blast and prime a section a day. This raises special concerns about contamination of the previously blasted and primed surface. Abrasive and dust can be picked up by the primer applied the previous day if the lining is slow-drying. Even if this contamination does not occur, the entire primer surface will have to be washed, vacuumed, or both to remove the dust and other contaminants.

The alternative is to completely blast the entire surface, clean up the work area, and apply the first layer or primer. This will require dehumidification equipment (May 2002 ATB) so the steel does not start to rust.

Continued

Curing the Lining

Linings can be classified as air-dried, low-baked (force-cured) or high-baked. Air-dried linings cure without additional heat, provided the ambient air temperature is within the manufacturer's specified range. Low-baked coatings are cured at temperatures between about 55 C and 120 C (130 and 250 F). High-baked linings are cured above 120 C (250 F). Low-baked coatings will require some air-drying time to allow the solvents to flash off. High-baked coatings may require air-drying and low-baking as the first steps. Ask the manufacturer about the drying time at each temperature and how quickly the temperature should be raised. Monitor temperatures with surface temperature thermometers or infra-red non-contact temperature guns at various locations. Temperature is usually measured on the outside surface of the tank. Large tanks may need a layer of insulation around the outside to maintain steel temperatures.

Ventilation may be needed during the entire curing process with closed top tanks.

Ventilation

Adequate ventilation will be needed during lining application and cure. Dehumidification can also assist in solvent release. (See the May 2002 ATB.) The ventilation must be set up recognising that all solvents are heavier than air. Air must flow over the lined surfaces to remove the solvent released as quickly as possible so that more solvent can escape from the lining. The product data sheet will contain information on how many days the coating needs to cure, i.e., reach its final properties. Ventilation may be needed during the entire curing process with closed-top tanks.

The tank cannot be loaded with product until final cure. This is when all solvents have been released and the lining has achieved its maximum properties. Without final cure, solvents may leach into the stored product, or the corrosion resistance of the lining will be compromised. The product data sheet will give the amount of time needed at various temperatures to achieve full cure. The actual time may be longer, especially for air-cured coatings, if the coatings are applied above the manufacturer's recommended thickness.

Inspection

Inspectors commonly perform holiday detection on tank linings in addition to the normal surface preparation and coating application inspections during any coating project. This is especially true in tanks or vessels that will hold a corrosive material. Corrosion only occurs when surfaces are in contact with water, and tanks designed to hold products that are in an aqueous (water) solution will be wet most of the time. Even tanks that hold organic materials, such as petroleum products, can corrode because such products may contain a small amount of water. That water is more dense than the petroleum product, and the two are not soluble. The water settles to the bottom of the tank where it can corrode the steel.

A small pinhole in the coating can cause rapid failure with contamination of the product, or cause an environmental release if the base or shell of the tank should get a hole when the steel is consumed by corrosion. Either low- or high-voltage holiday detection is performed, depending on whether the lining is less than or more than 500 microns (20 mils). (See the March 2001 ATB.) Every holiday detected must be repaired. Consult the lining manufacturer or the specification for proper repair methods. Perform the holiday detection before applying the final coat so that repaired holidays have a continuous topcoat over them. Holiday detection should also be performed before baking for linings that require baking. If not, the lining will be fully cured before the holidays are detected, and the lining material applied to repair the holidays will not stick to the surface.

Safety

Application of tank linings presents two special safety hazards. One is working in a confined space and the other is fire and explosion. Tanks and vessels usually fall under the definition of a confined space. A confined space is any area that is large enough for a person to enter, has restricted means for entry or exit, and is not designed for continuous occupancy. Federal and local confined space regulations need to be followed. Air-supplied respirators may be needed when applying the lining material. Solvents from the lining material are released into the tank, so the probability of exceeding the lower explosive limit (LEL) is high. The LEL is the minimum concentration of solvents in the air that will allow it to burn. Smoking or open flames should never be allowed during coating application and drying, especially when working in confined spaces.

Conclusion

Tank lining is exacting work. It requires a properly cleaned surface; lining material application within the specified range; and strict adherence to time/temperature requirements for mixing, application, and curing. The coating contractor should work with the lining manufacturer to help assure a successful application.

Reference

NACE RP0178, Fabrication Details, Surface Finish Requirements, and Proper Design Considerations for Tanks and Vessels To Be Lined for Immersion Service (Houston, TX: NACE International, 1995).