Testing and Evaluation of Protective Coatings Applied to the Exterior of Underground Propane Tanks

PROPANE education & research COUNCIL

Executive Summary

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Coatings help protect underground propane tanks from moisture, bacteria, and minerals. This study evaluates the performance of several coating types when exposed to different environmental conditions, offering marketers a comparative look at underground tank coating performance.

The Propane Education & Research Council (PERC) contracted KTA-Tator Inc. to conduct a study to determine the level of protection different coating systems provide, the tank areas that are least protected, and the consequences of coating damage. The results showed that, overall, powder coatings performed better than liquid coatings and that coatings on welded seam areas often performed worse than coatings on side or leg areas.

The study tested seven propane tank coatings from five U.S. propane tank manufacturers: American Welding & Tank, Liberty Tank & Vessels, Quality Steel Corporation, Thompson Tanks, and Trinity Industries. Each coating was evaluated through mechanical testing and environmental exposure testing to determine whether any conditions had weakening effects on the different tank coatings.

Testing Process

- **Tank Manufacturer**
- **Delivery**
- ***Group 1 Samples***
  - **Pre-environmental Mechanical Testing**
- ***Group 2 Samples***
  - **Accelerated Weathering**
  - **Chemical Immersion**
  - **Thermal Cycling**
  - **Post-environmental Exposure Mechanical Testing**

Methodology

Seven 500-gallon underground propane tanks, three with liquid-applied coatings and four with powder coatings, were purchased for testing. Each tank was inspected on arrival for imperfections and damage from coating application or tank transport. Two sets of samples were taken from each tank: Group 1 and Group 2. Group 1 samples were taken from the top, the side, the end, the weld seam, and the leg attachment and subjected to mechanical testing. Group 2 samples were taken from the side, the weld seam, and the leg attachment for environmental exposure testing and post-environmental mechanical properties assessment.

Group 1 samples underwent pre-environmental exposure mechanical testing for coating thickness, adhesion, hardness, impact resistance, and abrasion resistance. Group 2 samples underwent environmental exposure testing, starting with accelerated weathering (heat, light, and condensation cycling) to simulate the condition of tanks that have been stored for a reasonable length of time before sale and installation. Two holidays (coating discontinuities) were then drilled in each sample, which was half-immersed in a chemical solution while the remaining sample half was exposed to the solution vapor, to test corrosion resistance. Five solutions — nitric acid (2 percent), sodium chloride (10 percent), sodium hydroxide (pH12), sodium bicarbonate (pH10), and distilled water — were used to simulate the conditions of soil or groundwater (such as minerals, moisture, and acidic or alkaline conditions) that surround underground tanks. Instances of coating color change, gloss reduction, rusting, and blistering were recorded. The Group 2 samples were then put through thermal cycling, which involved extreme temperature changes and immersion in tap water, before being evaluated by the same mechanical tests as the Group 1 samples to determine whether exposure to environmental elements lessens tank coating durability.

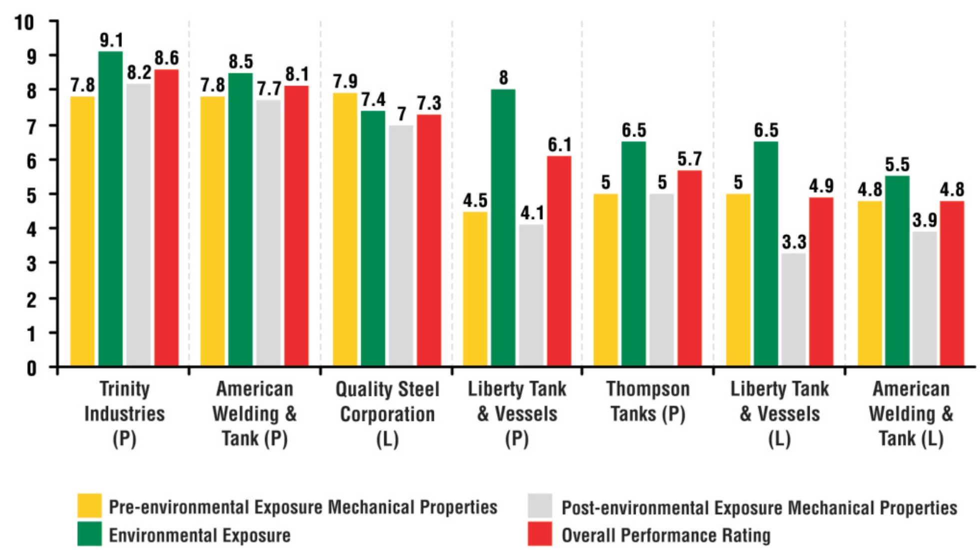
Results

Overall, the powder tank coatings outperformed the liquid tank coatings; three of the top four performing tank coatings were powder. Each test was assigned a number of possible performance points to determine each tank's overall performance ranking.

Six of the seven tanks arrived with extensive handling damage from common carrier delivery, while the tank delivered by the supplier arrived with only minor abrasions. The damaged tank coatings were not used for testing. However, the damages accrued during transport indicate the necessity of local delivery and proper handling with tank crane trucks and nylon lifting straps to avoid installation of damaged tanks that will have an increased likelihood of corrosion. The coating thickness averages of each tank were fairly consistent, with the exception of one tank (Liberty Tank & Vessels powder coating) that also had extensive pinholing, which is thought to have affected the tank's coating performance. The pre-environmental exposure mechanical tests did not show any overarching trend in mechanical performance.

Environmental exposure and post-immersion mechanical testing did indicate performance trends. Chemical immersion caused the most damage on the welded seam areas of five of the seven tanks while the performance of the side and leg attachment samples varied from tank to tank. Overall, the welded seam areas often had lower performance levels than the side and leg attachment samples for the same tank. The welded seam area exhibited the best performance on only one tank and the worst performance on four of the seven tanks. Contrasting the weld seam samples, the side wall samples performed the best on three of the tanks and the worst on only one tank, while the leg attachment samples had the highest performance on three tanks and the lowest on two tanks. In some cases, coating performance appeared to improve after environmental exposure testing, a result that researchers attributed to the hardening or the softening of the coating and the variations in coating thickness across samples. The figure below summarizes the performance results for pre-environmental exposure mechanical properties, environmental exposure, post-environmental exposure mechanical properties, and the overall performance ratings for each tank.

Manufacturer	Coating Type	Overall Performance (out of 10)
Trinity Industries	epoxy polyester powder (P)	8.6
American Welding & Tank	epoxy polyester powder (P)	8.1
Quality Steel Corporation	epoxy polyester urethane liquid (L)	7.3
Liberty Tank & Vessels	polyethlylene powder (P)	6.1
Thompson Tanks	coal tar epoxy powder (P)	5.7
Liberty Tank & Vessels	coal tar epoxy liquid (L)	4.9
American Welding & Tank	epoxy polyester liquid (L)	4.8



The ranking of the seven propane tanks used in this study on the basis of performance points should not be misinterpreted. Nothing in this report should be construed to suggest that the tanks that have received the lowest number of performance points and the lowest ranking overall, or in any category, are defective, dangerous, or subject to withdrawal from the market or from use in their intended application. Nothing in this report should be construed to suggest that any type of underground propane tank, or any underground propane tank with a particular type of coating, should not be used in the propane industry.

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