Liberty Tank & Vessels

Coal tar epoxy liquid coating

Overall Rating: 4.9

Key

low — high

S Tank Side Sample

W Weld Seam Sample

L Leg Attachment Sample

O Overall Sample

H in Holidays

V Vapor Phase

I Immersion Phase

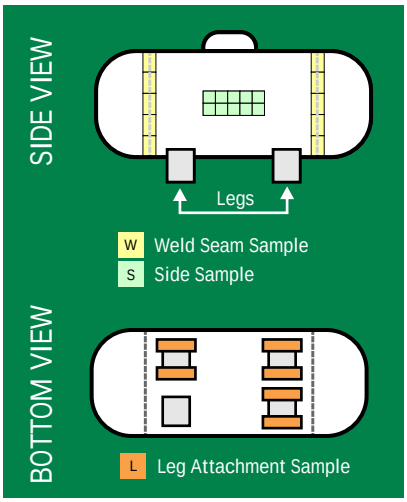
✓ No Change

● Minor

▲ Moderate

■ Severe

1-4 Blister Size (4=largest)



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

Mechanical Durability

Pre-Environmental Exposure	Post-Environmental Exposure: *Nitric Acid*	*Sodium Chloride*	*Sodium Hydroxide*	*Sodium Bicarbonate*	*Distilled Water*
Impact Resistance					
S,W,L	S,W,L	S,W — *L samples deteriorated*	S,W — *L samples deteriorated*	S,W — *L samples deteriorated*	S,W — *L samples deteriorated*
Adhesion Resistance					
S,W,L	S^{v} W^{I} L^{I} S^{I} W^{v},L^{v}	S,W^{v} L W^{I}	S^{v},L^{v} L^{I} S^{v} S^{I},W	S,L^{I} L^{v} W	S,W,L^{v} L^{I}
Coating Hardness					
S,W,L	S,W,L	S,W,L	S,W,L	S,W,L	S,W,L
Abrasion Resistance					
S,W,L	S,W,L	S,W,L	S,W,L	S,W^{v},L W^{I}	S,W^{v},L W^{I}

**In some cases the mechanical properties improved after exposure, which may be related to hardening or softening of the coating, or variations in coating thickness across the samples.*

Environmental Exposure Testing

Accelerated Weathering—250 hours

Severe color change (black to brown) and gloss reduction; rust spots on most samples

Chemical Immersion—90 Days

Tank Area and Results	*Nitric Acid*	*Sodium Chloride*	*Sodium Hydroxide*	*Sodium Bicarbonate*	*Distilled Water*
Side Wall					
Color & Gloss	▲O^{v}, ■O^{I}	▲O^{v}, ■O^{I}	■O	▲O^{v}, ■O^{I}	▲O – ■O
Rusting	■H^{I}	●H	●O^{I}	✓	●H
Blistering	3■O^{I}, 2■O^{v}	✓	✓	✓	✓
Weld Seam					
Color & Gloss	●O^{v} – ▲O^{v}, ■O^{I}	▲O – ■O	▲O – ■O *	▲O – ■O	▲O – ■O
Rusting	✓	●O^{I}	✓	✓	✓
Blistering	3■O	✓	✓	✓	2▲O^{I}
Leg Attachment					
Color & Gloss	●O^{v} – ▲O^{v}*, ■O^{I}*	■O	▲O – ■O *	▲O^{v}, ■O^{I}	●O – ▲O*
Rusting	✓	▲O^{I}	✓	✓	✓
Blistering	✓	✓	✓	✓	✓

** Indicates that the top layer of the coating disbanded from the rest of the coating*

Thermal Cycling—30 24-hour cycles

*Nitric acid weld seam**
Rusting: ●O

Nitric acid leg attachment
Blistering: 3■O

*Sodium bicarbonate leg attachment**

*Sodium chloride weld seam**

Sodium chloride leg attachment
Rusting: ▲O

Sodium bicarbonate side wall
Color & Gloss: ■O^{I}

*Sodium hydroxide side wall**
Blistering: 2■O^{I}

Sodium hydroxide leg attachment
Rusting: ●O

** Indicates that the top layer of the coating disbanded from the rest of the coating*

Research was provided by KTA-Tator Inc. under PERC Docket 12469, *Testing and Evaluation of Underground Propane Tank Coatings.* The information provided in this document is intended only as a summary of the tank coating performance results; for more detailed findings, please reference the full report.

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.

The tank evaluation results have been summarized through the following methods.

Mechanical Durability:

The front page of this document provides a side-by-side comparison of tank performance both before and after environmental exposure (accelerated weathering, chemical immersion, and thermal cycling). KTA-Tator provided pre- and post-environmental exposure test data for tank samples taken from the tank weld seam, side wall, and leg attachment.

The low-to-high scales indicate the performance range unique to each test. Raw performance data was used to rank each sample on the appropriate test's scale:

Impact Resistance

<92 96 100 104 >108

in-lbs resistance from 4-lb weight dropped on samples from set distances

Adhesion Resistance

0 1.25 2.5 3.75 5

Some tanks have two values for the same sample to indicate the adhesion between tank coating layers (usually a higher value) and the adhesion resistance between the tank coating and the tank steel

Adhesion Method A - X cut
(coating thickness > 5 mils)

5A No peeling or removal
4A Trace peeling or removal along incisions or at their intersection
3A Jagged removal along incisions up to 1/16 in. on either side
2A Jagged removal along most of incisions up to 1/8 in. on either side
1A Removal of most of the area of the X under the tape
0A Removal beyond the area of the X

Adhesion Method B - Grid cut
(coating thickness < 5 mils)

5B No coating removal
4B 1 - 5% coating removal
3B 6 - 15% coating removal
2B 16 - 35% coating removal
1B 36 - 65% coating removal
0B >65% coating removal

Coating Hardness

6B 4B 2B HB/F 2H 4H 6H

Resistance to coating damage from increasing pencil lead hardness

6B 5B 4B 3B 2B B HB F H 2H 3H 4H 5H 6H

Softer *Medium* *Harder*

Abrasion Resistance

>1.0 0.825 0.75 0.625 <0.5

Coating thickness reduction in mils (thousandths of an inch);
report scoring system did not include the whole data range in the low-high scale

Chemical Immersion:

The report includes data for 30-day, 60-day, and 90-day chemical immersion periods. The 90-day results are summarized in this document to demonstrate the longer-term effects of chemical immersion. Color and gloss changes, rusting, and blistering are classified as minor, moderate, or severe for visual purposes using the following scales:

Color and gloss change

- Severity was labeled as minor, moderate, or severe in the report.

Rusting

- Evaluated according to SSPC VIS 2/ASTM D 610, "Evaluating Degree of Rusting on Painted Steel Surfaces."
  - In some cases, rusting was classified as minor/moderate/severe within the report.
  - In other cases, the following numbers were used: 10 (<0.03%); 9 (0.03%); 8 (0.1%); 7 (0.3%); 6 (1%); 5 (3%); 4 (10%), 3 (16%); 2 (33%); 1 (50%).
  - These frequencies are visually conveyed through the following system:

✓ No change
● 8–10 = Minor
▲ 4–7 = Moderate
■ 1–3 = Severe

Rusting at holidays=minor; corrosion undercutting at perimeter of holidays=moderate; rusted through holidays=severe

Rust creep and rust along the weld indicate the presence of rust but is unable to be classified as minor, moderate, or severe

Blistering

- Blister sizes given in report: 2, 4, 6, 8, according to ASTM D 714, "Evaluating the Degree of Blistering of Paints."
  - Blister sizes given in the report indicated 8 as the smallest blister size and 2 as the largest blister size.
  - To aid presentation, these ratings were inversed to a 1–4 scale to show a larger number as a larger blister size.

- Blister frequencies given in report: Few, Medium, Medium Dense, Dense for blister density, according to ASTM D 714.
  These frequencies are visually conveyed through the following system:

✓ No change = no blistering
● Few = minor
▲ Medium = moderate
▲–■ Medium Dense = moderate-severe
■ Dense = severe