

A Coating with Superior Chemical Resistance, with High Impact Resistance, and Elongation Virtually Equal to Steel, for Chemical and Product Tankers



The MarineLine[®] Enhanced cargo tank coating has been engineered to provide both high chemical resistance, and high impact resistance, as requested by shipowners to withstand mechanical damages that may be incurred during cleaning, repairs, etc. Advanced Polymer Coatings' MarineLine Enhanced is a tougher version of its previous coating system.

With this R&D breakthrough, several other features have also been realized, thus adding significantly to the overall performance of the coating. Key benefits of the enhanced formulation include:

- ▶ **Increased Impact Resistance more than 50%** creating a tougher, more durable coating.
- ▶ **Increased Coating Elongation (flexibility) more than 100%**, to virtually match the carbon steel cargo tank.
- ▶ **Reduced Surface Energy almost 60%** for easier, faster tank cleaning.

Description

MarineLine[®] Enhanced is a high functionality two component polymer coating having enhanced properties:

- ▶ Impact resistance
- ▶ Toughness
- ▶ Elongation virtually equal to steel
- ▶ Abrasion resistance
- ▶ Lower surface energy

Superior Chemical Resistance to:

- ▶ 1% to 98% Sulfuric Acid
- ▶ 1% to 80+% Phosphoric Acid
- ▶ 10% to 73% Sodium Hydroxide
- ▶ Methanol
- ▶ Methylene Chloride
- ▶ Sodium Hypochlorite
- ▶ Acetic Acid
- ▶ Most Acids, Alkalis and Solvents
- ▶ Wine and Edible Oils (complies with all FDA regulations – GRAS)



Product Highlights

- ▶ Superior corrosion resistance with outstanding flexibility
- ▶ Superior bonding qualities
- ▶ Maximum product (chemical) versatility, product cycling
- ▶ Virtually non-permeable and steam cleanable
- ▶ Field repairable
- ▶ Complies with all FDA regulations
- ▶ MarineLine® is generally recognized as safe (GRAS) for food grade products
- ▶ High impact resistance
- ▶ Dry heat resistance to 350°F (177°C), immersion temperature depending on chemical

Typical Properties

- ▶ Color (Normal) _____ Gray/Red/White
- ▶ VOC Level _____ 42 grams/liter (0.33 lbs/gallon)
- ▶ Pot Life _____ 60 minutes @ 24°C (75°F)
- ▶ Flash Point _____ 66°C (151°F)
- ▶ Solids by Weight _____ 98% (± 1)
- ▶ Theoretical Coverage ____ 3.25 SqM/L @ 300 microns
- ▶ Recommended DFT ____ Average: Steel @ 300 microns
- ▶ Shelf Life _____ 12 months
- ▶ Elongation (ASTM D522) _____ 12-15%

Physical Properties



The elongation of MarineLine® Enhanced coating (12-15%) virtually matches carbon steel's elongation (12-18%), as shown in these actual bend photographs. Note how the coating elongates and 'flexes' with the severe bend.

- ▶ Impact Resistance (ASTM D2794) _____ 200in/lbs
- ▶ Pull Off Strength (ASTM D4541) ____ 2800-3100 PSI
- ▶ Tabor Abrasion Resistance _____ 4.2mg/1000 cycles (ASTM 4060)
(CS-17, 1000g Load, 1000 cycles)

MarineLine® Enhanced surface energy has also been reduced +57% for easier cleaning.

Coating Inspection & Monitoring by APC

To ensure the performance of MarineLine® Enhanced, it is imperative that APC provides inspection services throughout the entire application process. APC focuses on the importance of good surface preparation, correct application and proper heat cure, in a 6-Step approach. MarineLine® has set the benchmark regarding heat curing, and spark testing the entire tank surface.

Step 1 Pre-Blast

- Weld & Grind Inspection
- Staging • Dehumidification
- Ventilation • Rain Protection
- Surface Contamination Testing
- Surface Protection



Step 2 Blasting

- Surface Profile
- Surface Cleanliness
- Environmental Conditions
- Cleaning • Blasting
- Visual Blast Inspection
- Rejection of Blast Quality



Step 3 Spray Application

- Environmental Conditions
- Mixing Thinners
- Base Coat (shown here)
- Stripe Coat
- Top Coat



Step 4 Inspection

- Dry Film Thickness Test
- Spark Test



Step 5 Heat Cure

- Equipment
- Set-up
- Charting
- Curing



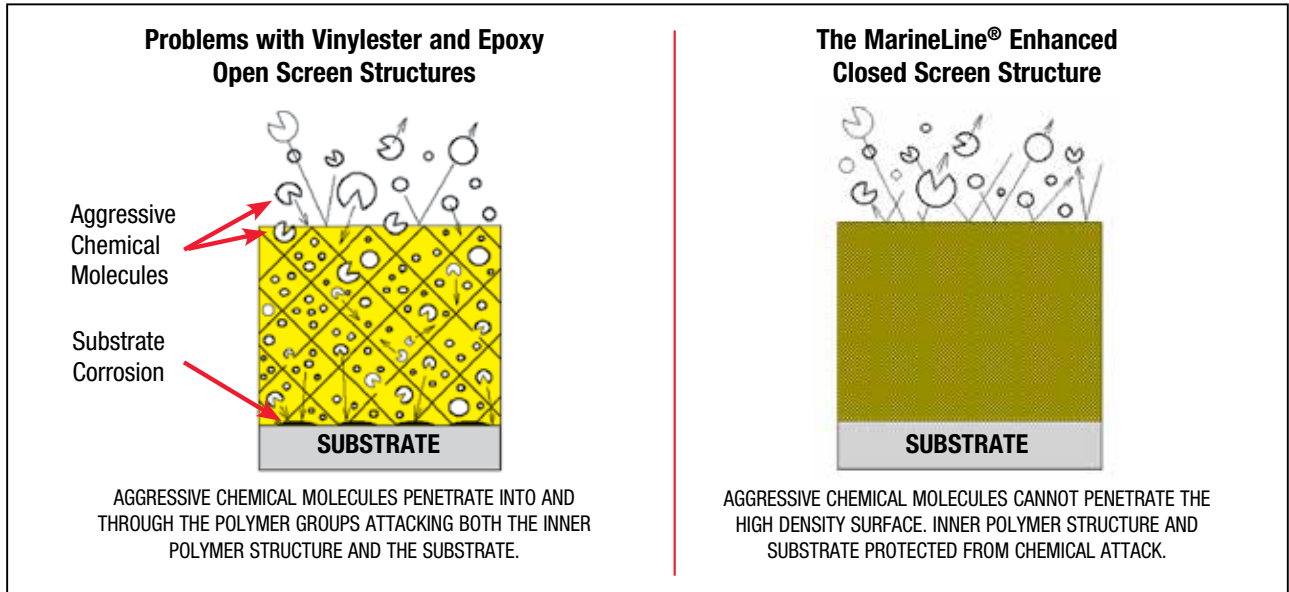
Step 6 Final Inspection

- Hardness Test
- Solvent Wipe Test
- Inspection Report Prepared



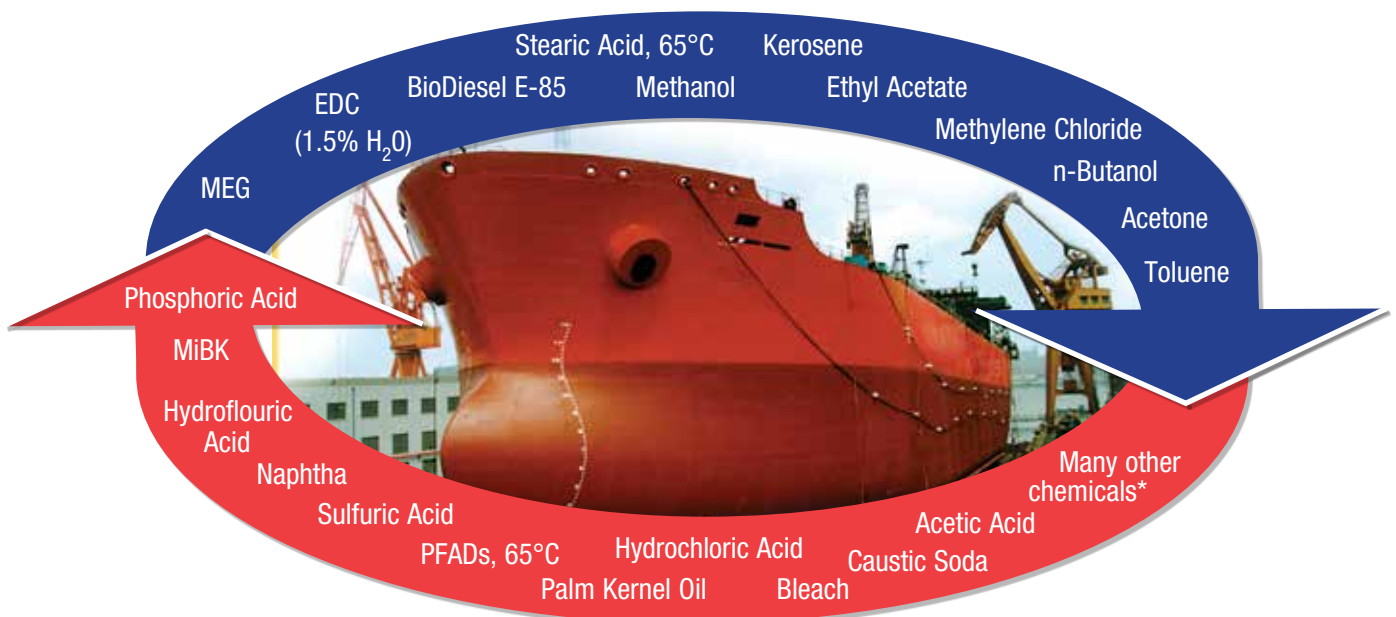
MarineLine® Enhanced Technology Has Higher Functionality, Producing Higher Crosslink Density with High Flexibility

- Higher chemical resistance
- Higher temperature resistance
- Resistance to permeation (absorption)



Protecting Your Assets

- ▶ MarineLine® Enhanced Solves Your Corrosion Problems.
- ▶ MarineLine® Enhanced Gives You Corrosion Resistance with Toughness, and Versatility to Change from One Chemical to Another with Easier Cleaning.



* See Advanced Polymer Coatings MarineLine® Chemical Resistance Brochure.

MarineLine® Enhanced Offers Greater Versatility

A = Good at ambient temperatures
 L = Limited Service
 N = Not recommended

This is Only A Reference Guide.

This is an abbreviated listing of the more than 5,000 chemicals that have been tested. This information is intended to serve as a reference guide only. The end user is responsible for determining if MarineLine® Enhanced is the appropriate coating for the specific application involved.

Corrosion resistance data from published literature.

	<i>MarineLine® Enhanced</i>	<i>Phenolic Epoxy</i>	<i>Stainless Steel</i>	<i>Inorganic Zinc</i>
Acetic Acid	A	N	A	N
Acrolein Acid	A	N	A	N
Acrylic Acid	A	N	A	N
Acrylonitrile, 35°C	A	N	A	A
Ammonium Persulfate	A	A	L	N
Azabenzene	A	N	A	N
Benzene	A	A	A	A
Benzene Carboxylic Acid	A	A	A	N
B-Methacrylic Acid	A	N	A	N
Bichromate of Soda	A	N	A	N
Bio Fuels	A	L	A	A
Butanoic Acid	A	N	A	N
Butyric Aldehyde	A	N	A	N
Calcium Hydroxide	A	A	A	N
Caustic Potash	A	N	A	N
Carbolic Acid	A	N	A	L
Coal Tar Oil	A	N	A	L
Colamine	A	N	A	—
Cresol	A	N	A	A
Detergents	A	A	A	N
Diethylamine	A	N	A	A
Diethyl Ether	A	N	A	A
Dimethylamide Acetate	A	N	A	N
Disulphuric Acid	A	N	A	N
Ethylene Dichloride (EDC)	A	L	N	N
EDTA	A	N	A	N
Ethenal	A	A	A	A
Ethanolamine	A	N	A	N
Ethonic Acid Anhydride	A	N	A	N
Ethyl Acrylate	A	A	A	N
Fatty Acids	A	A	A	N
Formic Acid 10%	A	N	A	N
Glycerol	A	N	A	N
Heptanoic Acid	A	A	A	N
Hexahydroaniline	A	N	A	L
HMDA	A	N	A	L
Isobutanol	A	N	A	N
Isobutyric Acid	A	N	A	N
Isopropyl Amine	A	N	A	N
Juices, Fruit	A	A	A	N
Liquid Pitch Oil	A	N	A	L

	<i>MarineLine® Enhanced</i>	<i>Phenolic Epoxy</i>	<i>Stainless Steel</i>	<i>Inorganic Zinc</i>
Maleic Anhydride	A	N	A	N
MCA	A	N	A	N
Methacrylonitrile, 35°C	A	N	A	N
Methanol	A	N	A	A
MEK	A	L	A	A
Methylene Chloride	A	N	N	N
Mono Ethylene Glycol (MEG)	A	A	A	N
Nitrogen Fertilizers	A	A	A	N
Norval Amine	A	N	A	N
Octanoic Acid	A	A	A	N
Orthonitro Benzene	A	N	N	N
Palm Fatty Acid (PFAD)	A	A	A	N
Perchloroethylene	A	N	A	N
Phenol	A	N	A	A
Phosphoric Acid	A	N	L	N
Phthalic Anhydride	A	N	A	N
Piperzine	A	N	A	A
Polyethylene Polyamines	A	N	A	N
Potassium Hydroxide	A	A	L	N
Potassium Permanganate	A	A	L	N
Propionic Acid	A	N	A	N
Pyridine	A	N	A	N
Sodium Carbonate	A	N	N	N
Sodium Hydroxide	A	A	L	N
Sodium Sulfide	A	A	N	N
Stearic Acid	A	A	A	N
Styrene Monomer	A	L	A	A
Spent Sulfuric Acid	A	N	A	N
Sulfur	A	N	A	N
Sulfuric Acid 1-70%	A	A	N	N
Sulfuric Acid 70-99%	A	N	L	N
Sulphurous Acid	A	N	A	N
Tall Oil	A	A	A	N
Tallow	A	A	A	N
Tar Acid	A	N	A	N
Toluene	A	N	A	A
Valeraldehyde	A	N	A	N
Vinegar	A	N	A	N
Vitriol Oil 65%	A	N	A	N
Xylenol	A	N	A	A

Application Data

Note: The following application data is provided as a General Guide Only. Detailed instructions are provided for the MarineLine® Enhanced coating system. Only full detailed application specifications are to be used during actual application.

Note: MarineLine® Enhanced is shipped in a highly viscous state for heated plural spraying. For airless spraying, Toluene must be used for thinning.

Thinning

It is always necessary to thin MarineLine® coating, EXCEPT if using Heated Plural Spray equipment. The following thinning instructions should be followed.

VOC Content			
MarineLine® Enhanced as Supplied		Coating Thinned with 2% Toluene by Weight	
Lbs/Gallon	Grams/Liter	Lbs/Gallon	Grams/Liter
0.33 ± 1%	42 ± 1%	0.14 ± 1%	61 ± 1%

The applicator should make exact thinner adjustments based on the equipment used, and air and surface temperature.

Note: Add and mix solvent into Part 'A' prior to adding Catalyst Part 'B'.

Surface Preparation

Steel: Grit blast to SSPC-SP10 Near White Profile 3 to 4 mils (75 to 100 microns)

Mixing Instructions

Material is supplied in two containers as a unit. Always mix a complete unit as supplied (do not split units).

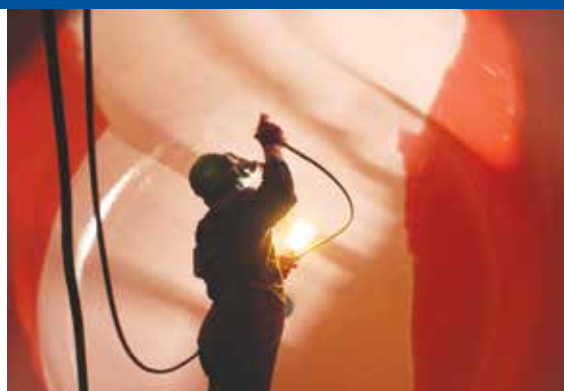
1. Thoroughly mix the contents of Part 'A' with additional solvent with a power agitator until uniform consistency and all solids have been put back into suspension.
2. Slowly mix in the contents of Part 'B' Catalyst with previously mixed Part 'A'.
3. Thoroughly mix the two parts until a uniform consistency and color is achieved.

Clean Up Solvent

Acetone, Xylene or Toluene

Limitations

Apply when the air and surface temperatures are above 15°C (59°F). Relative humidity must be kept at 70% or lower. The substrate temperature should be at least 3°C (5°F) above the dew point and rising. For optimum application properties, bring material to 21-30°C (70-86°F) prior to mixing and application. Increased temperatures will result in shorter pot life.



Application

Airless spray equipment with a minimum 43:1 pump ratio @ 80-100 lbs. to achieve 2500-3000 psi tip pressure: Reverse-A-Clean tip .019 to .023, with a 3/8" fluid hose, and 1/4" whip hose. This coating is a low VOC compliant material. If conditions require a viscosity adjustment, thin with Toluene.

Apply first coat to wet film thickness of 5-6 mils (125-150 microns). Allow to dry to touch approximately 10 to 16 hours depending on temperature and airflow. Apply second coat to wet film thickness of 5-6 mils (125-150 microns), total 10-12 mils average (250-300 microns average).

Inspection

After second coat has dried and will not move when pressed with a finger, the inspection can take place (spark testing, DFT) and repairs can be made prior to heat curing.

Cure Time and Temperature

In order to handle aggressive chemicals, MarineLine® has to be fully cured to avoid problems. The following curing method is used:

A forced hot air curing at 90°C (194°F) to 122°C (250°F) for minimum 6 hours. Electrically heated or gas combustion air only to be used.

Note: All temperatures are metal temperatures. See Full Specification for application of MarineLine® Enhanced coating.

Handling Precautions

Solvents and chemicals are contained in this product. Consult the Material Safety Data Sheet for details. Adequate safety and health precautions should be taken during handling, application and drying of this product. The material should be applied under local, state, and federal regulations and in accordance with OSHA and ANSI bulletins on safety requirements.

Packaging

Available as:

- 5 gallon kit with catalyst
- 1 gallon kit with catalyst

MarineLINE[®] Enhanced

A History of Performance

MarineLine[®] Enhanced is based on APC's MarineLine[®] cargo tank coating that has been applied to more than 700 maritime chemical and product tankers, covering over 10 million square meters of surface.

- The majority of ships coated are over 8 years old with some over 15 years old.
- MarineLine[®] has been applied successfully in major shipyards around the world.
- These tankers have carried thousands of different chemicals, including Acids, Caustics, Solvents, Inorganic Chemicals, and Edible Oils, with some tankers changing their chemical cargoes up to 85 voyages a year.
- APC's MarineLine[®] coating withstands the stresses of twisting and bending in rough seas while resisting temperature extremes of the cold Baltic winters to the hot Middle East summers.

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The information, evaluations and statements herein pertain to the material currently offered and represent the tests believed to be dependable. Published technical data and instructions are subject to change. Consult your Advanced Polymer Coatings representative

for coating recommendations. Product covered under one or more of the following Patents or Patents Pending. 5,169,912, 5,658,966, or 5,874,501

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