

Linings of Aboveground Petroleum Storage Tank Bottoms

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Contents

	Page
1 Scope	1
2 Normative References	1
3 Terms and Definitions	2
4 Corrosion Mechanisms	6
4.1 General	6
4.2 Chemical Corrosion	6
4.3 Concentration Cell Corrosion	6
4.4 Oxygen Cell Corrosion	7
4.5 Galvanic Cell Corrosion	7
4.6 Microbiologically Influenced Corrosion (MIC)	7
4.7 Erosion-corrosion	7
4.8 Fretting-related Corrosion	8
4.9 Generalized vs Localized (Pitting) Corrosion	8
4.10 Stress Corrosion Cracking	8
4.11 Internal Corrosion Mechanisms	8
5 Determination of the Need for Tank Bottom Lining	9
5.1 General	9
5.2 Linings for Corrosion Protection	9
5.3 Tank Corrosion History	9
5.4 Tank Foundation	10
6 Tank Bottom Lining Selection	10
6.1 General	10
6.2 Inorganic Zinc/Zinc Silicate (IOZ)	11
6.3 Thin-film Tank Bottom Linings	12
6.4 Thick-film Unreinforced Tank Bottom Linings	13
6.5 Reinforced Thick-film Tank Bottom Linings	14
6.6 Circumstances Affecting Lining Selection	16
6.7 Selecting Internal Linings for Tanks Storing Alternate Fuels	18
7 Surface Preparation	20
7.1 General	20
7.2 Pre-cleaning	21
7.3 Bottom Repair and Subsequent Weld and Component Preparation	21
7.4 Surface Cleanliness	21
7.5 Surface Profile or Anchor Pattern	22
7.6 Air and Abrasive Cleanliness	22
7.7 Removal of Salts	22
7.8 Removal of Dust	22
8 Lining Application	22
8.1 General	22
8.2 Guidelines for Lining Application	23
8.3 Temperature and Humidity Control	23
8.4 Lining Thickness	23
8.5 Lining Curing	23

Contents

	Page
9 Inspection	24
9.1 General.....	24
9.2 Qualification of Inspection Personnel	24
9.3 Recommended Inspection Parameters	24
10 Evaluation, Repair, and Replacement of Existing Linings	25
10.1 General.....	25
10.2 Evaluation Methods.....	25
10.3 Evaluation Criteria for Linings	25
10.4 Evaluating Serviceability of Existing Linings	26
10.5 Determining the Cause of Lining Degradation/Failure	26
10.6 Lining Repair and Replacement	26
11 Maximizing Lining Service Life by Proper Material Selection and Specification	27
11.1 General.....	27
11.2 Lining Material Selection	28
11.3 Written Specification.....	28
12 Health, Safety, and Environmental	28
12.1 General.....	28
12.2 Tank Entry	29
12.3 Surface Preparation and Lining Application	29
12.4 Manufacturer's Safety Data Sheets.....	29
Bibliography.....	30

Linings of Aboveground Petroleum Storage Tank Bottoms

1 Scope

This recommended practice (RP) provides guidance on achieving effective corrosion control in aboveground storage tanks by application of tank bottom linings. It contains information pertinent to the selection of lining materials, surface preparation, lining application, cure, and inspection of tank bottom linings for existing and new storage tanks. In many cases, tank bottom linings have proven to be an effective method of preventing internal corrosion of steel tank bottoms.

The intent of this RP is to provide information and guidance specific to aboveground steel storage tanks in hydrocarbon service. Certain practices recommended herein may also be applicable to tanks in other services. This RP is intended to serve only as a guide. Detailed tank bottom lining specifications are not included.

Because of the wide variety of service environments, this RP does not designate specific tank bottom linings for every situation.

NACE No.10/SSPC-PA 6 and NACE No. 11/SSPC-PA 8 are industry consensus standards for installation of linings on tank bottoms and vessels. They are written in compulsory language and contain specific criteria intended for use by persons who provide written specifications for tank and vessel linings. These documents should be given consideration when designing and installing a lining system for steel bottom tanks.

2 Normative References

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any addenda) applies.

API Bulletin 939-E, *Identification, Repair, and Mitigation of Cracking of Steel Equipment in Petroleum Refineries and Petrochemical Plants*

API Recommended Practice 651, *Cathodic Protection of Aboveground Petroleum Storage Tanks*

API Standard 653, *Tank Inspection, Repair, Alteration, and Reconstruction*

API Standard 2015, *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks*

ASTM D4285,¹ *Standard Test Method for Indicating Oil or Water in Compressed Air*

ASTM D4414, *Standard Practice for Measurement of Wet Film Thickness by Notch Gages*

ASTM D4940, *Standard Test Method for Conductimetric Analysis of Water Soluble Ionic Contamination of Blasting Abrasives*

ASTM E96, *Standard Test Methods for Water Vapor Transmission of Materials*

ASTM G9, *Standard Test Method for Water Penetration into Pipeline Coatings*

NACE 37519,² *Corrosion Data Survey—Metals Section*

¹ ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, Pennsylvania 19428-2959, www.astm.org.

² NACE International (formerly the National Association of Corrosion Engineers), 15835 Park Ten Place, Houston, Texas 77084, www.nace.org.

NACE SP0178, *Fabrication Details, Surface Finish Requirements, and Proper Design Considerations for Tanks and Vessels to be Lined for Immersion Service*

NACE No. 1/SSPC-SP 5, *White Metal Blast Cleaning*

NACE No. 2/SSPC-SP 10, *Near-White Metal Blast Cleaning*

NACE No. 10/SSPC-PA 6, *Fiberglass-Reinforced Plastic (FRP), Linings Applied to Bottoms of Carbon Steel Aboveground Storage Tanks*

NACE No. 11/SSPC-PA 8, *Thin-Film Organic Linings Applied in New Carbon Steel Process Vessels*

NACE 6A192/SSPC-TR 3, *Dehumidification and Temperature Control During Surface Preparation, Application, and Curing for Coatings/Linings of Steel Tanks, Vessels, and Other Enclosed Spaces*

U.S. DOL Title 29, CFR Part 1910.132,³ *Personal Protective Equipment, General Requirements*

U.S. DOL Title 29, CFR Part 1910.146, *Permit-Required Confined Spaces*

U.S. DOL Title 29, CFR Part 1926.62, *Lead (Construction Industry Standard)*

OSHA Publication 2254,⁴ *Training Requirements in OSHA Standards and Training Guidelines*

SSPC Guide 15,⁵ *Field Methods for Extraction and Analysis of Soluble Salts on Steel and Other Nonporous Substrates*

SSPC-PA 1, *Shop, Field, and Maintenance Painting of Steel*

SSPC-PA 2, *Procedure for Determining Conformance to Dry Coating Thickness Requirements*

SSPC-SP 1, *Solvent Cleaning*

SSPC-SP 11, *Power Tool Cleaning to Bare Metal*

3 Terms and Definitions

For the purposes of this document, the following definitions apply.

3.1

aboveground storage tank

A stationary container, usually cylindrical in shape, consisting of a metallic roof, shell, bottom, and support structure where more than 90 % of the tank volume is above surface grade.

3.2

anchor pattern

anchor profile

profile

surface profile

Surface contour or roughness of a blast-cleaned or substrate surface, when viewed from the edge.

³ The Code of Federal Regulations is available from the U.S. Government Publishing Office, 732 N. Capitol Street, NW, Washington, DC 20401, www.gpo.gov.

⁴ U.S. Department of Labor, Occupational Safety and Health Administration, 200 Constitution Avenue, NW, Washington, DC 20210, www.osha.gov.

⁵ The Society for Protective Coatings, 800 Trumbull Drive, Pittsburgh, Pennsylvania 15205, www.sspc.org.

3.3

anode

The electrode of an electrolytic cell in which oxidation is the principal reaction.

NOTE Electrons flow away from the anode toward the cathode in the external circuit. It is usually the electrode where corrosion occurs, and metal ions enter solution.

3.4

cathode

The electrode of an electrolytic cell at which reduction is the principal reaction. Electrons flow toward the cathode in the external circuit.

3.5

cathodic protection

A corrosion control system in which the metal to be protected is made to serve as a cathode, either by the deliberate establishment of a galvanic cell or by impressed current. (See anode and cathode.)

3.6

caulk

Products used in order to fair or smooth surfaces, as well as seal seams and rivets in lining applications.

3.7

coating

A paint or other finish used to create a protective or decorative layer.

3.8

concentration cell

An electrochemical cell, the electromotive force (EMF) of which is caused by a difference in concentration of some component in the electrolyte, or electrolytes containing different substances.

NOTE This difference leads to the formation of discrete cathode and anode regions.

3.9

corrosion

The chemical or electrochemical reaction between a material, usually a metal, and its environment that produces a deterioration of the material and its properties.

3.10

corrosion protection

The minimization of corrosion using linings for exposed steel surfaces and cathodic protection or vapor corrosion inhibitors for concealed tank bottom steel plate surfaces.

3.11

cure, curing

The process whereby a liquid coating becomes a hard film. Curing is complete when the lining is ready to accept immersion in the designated service.

NOTE Methods of testing cure include solvent rub and hardness testing.

3.12

dew point

Temperature at which moisture will condense from vapors into a liquid state.

3.13

differential aeration cell

A concentration cell caused by differences in oxygen concentration along the surface of a metal in an electrolyte. (See oxygen concentration cell.)

3.14**electrochemical cell**

An electrochemical system consisting of an anode and a cathode in metallic contact and immersed in an electrolyte.

NOTE The anode and cathode may be different metals or dissimilar areas on the same metal surface.

3.15**electrolyte**

A nonmetallic substance that carries an electric current or a substance which when dissolved in another medium, such as water, separates into ions which can carry an electric current.

3.16**epoxy**

Extremely tough and durable synthetic coating resins that are highly resistant to chemicals, abrasion, moisture, and in some cases, alcohols.

3.17**fiberglass-reinforced plastic****FRP**

Resin linings, usually polyester, vinyl ester, or epoxy into which layers of fiberglass are incorporated to optimize the lining's structural capability and performance. See NACE No. 10/SSPC-PA 6.

3.18**forced curing**

Acceleration of curing by increasing the temperature above ambient, accompanied by forced air circulation.

3.19**fretting corrosion**

Deterioration at the interface between contacting surfaces as the result of corrosion and movement between the two surfaces.

3.20**holiday**

A discontinuity in a protective coating that exposes unprotected surface to the environment. Also refers to application defects whereby small areas are left uncoated.

3.21**lining**

A liquid paint applied to the interior surfaces of a vessel that develops strong adhesion to the substrate and is designed for immersion service or vapor-space service for a specified stored product.

NOTE A lining can be reinforced or unreinforced.

3.22**mil**

One one-thousandth of an inch (0.001 in.).

NOTE One mil = 25.4 μm ; it is common practice to use 1 mil = 25 μm .

3.23**mill scale**

The heavy oxide layer formed during hot fabrication or heat treatment of metals, typically a black-blue colored smooth layer found on the surface.

3.24**oxygen concentration cell**

A concentration cell caused by differences in oxygen concentration along the surface of a metal in an electrolyte. (Also referred to as: differential oxygen cell, or differential aeration cell.)

3.25**phenolic**

A resin of the phenol formaldehyde type.

NOTE Phenolic and novolac epoxies tend to be more chemically resistant.

3.26**primer**

First complete coat applied to the prepared surface.

NOTE Holding primers are often used in tank linings when operational issues require daily coating of the blasted surface.

3.27**stress corrosion cracking****SCC**

The fracture of a metal by the combined action of corrosion and tensile stress. The fracture occurs under a tensile stress that may be well below the tensile strength or even the yield strength of the material.

3.28**thick-film lining**

A lining with a dry film thickness (DFT) of 20 mils (500 μm) or more.

3.29**thin-film lining**

A lining with a DFT less than 20 mils (500 μm).

3.30**vinyl ester**

A chemically resistant resin frequently used in flake coatings as well as in the fiberglass-reinforced thick-film systems.

NOTE This product may contain styrene, which is on the hazardous air pollutants (HAPS) list and is a carcinogen.

3.31**volatile corrosion inhibitor****VCI**

A type of corrosion inhibitor that is used to protect ferrous materials and non-ferrous metals against corrosion or oxidation, where it is impractical to apply surface treatments. It works by slowly releasing chemical compounds within a sealed airspace that actively prevents surface corrosion.

3.32**volatile organic compound****VOC**

Compounds of carbon that have high vapor pressure and low water solubility.

NOTE VOCs typically are industrial solvents, fuel oxygenates, or components of petroleum fuels. VOC content in coatings is highly regulated. Specifiers should be aware of the jurisdiction and regulations in the geography where the coating is to be applied prior to specifying a coating product.

3.33**water bottom**

A water layer in the bottom of a tank caused by separation of water and product due to differences in solubility and specific gravity.