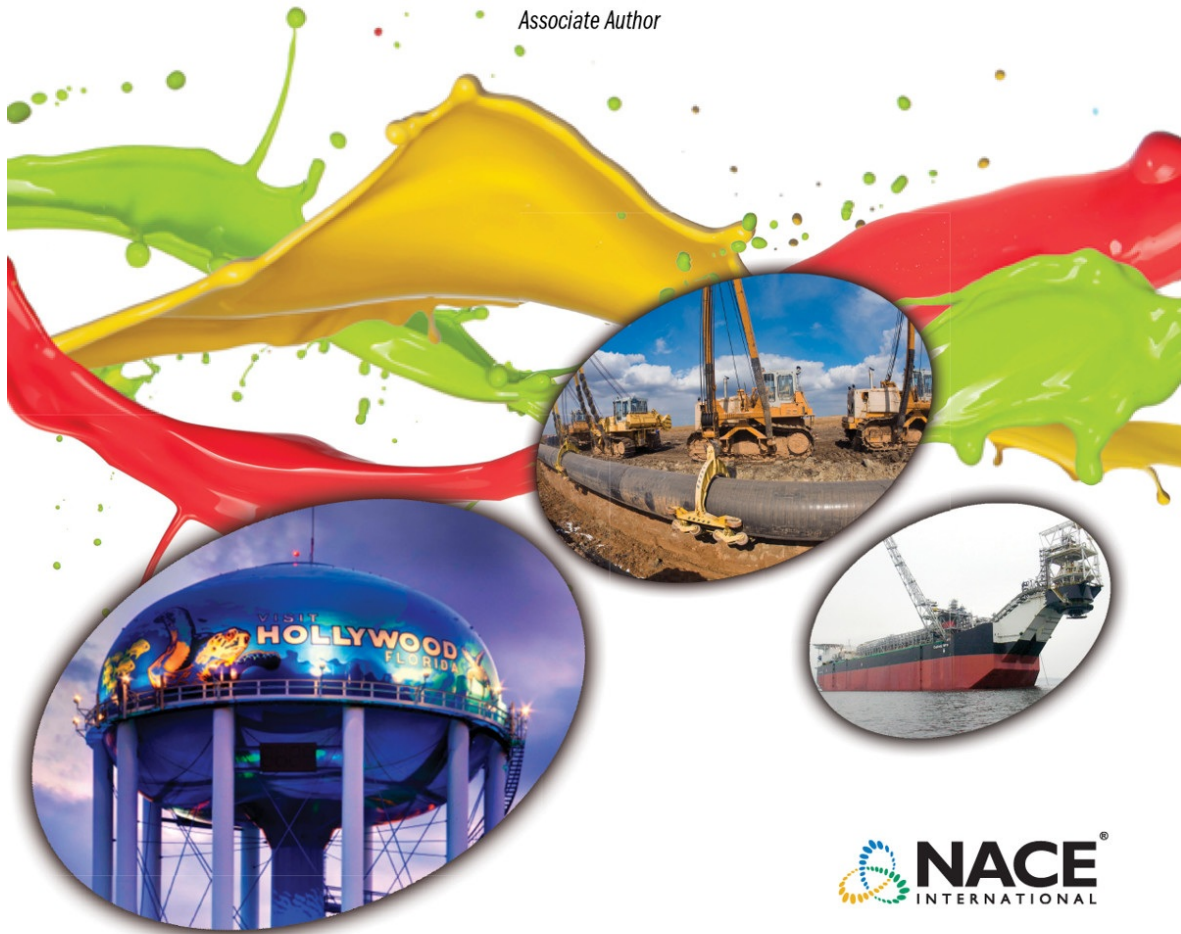


Corrosion Prevention by Protective Coatings

Third Edition

Charles G. Munger

Louis D. Vincent, Ph.D.
Associate Author



Corrosion Prevention by Protective Coatings

Third Edition

Charles G. Munger

Louis D. Vincent, Ph.D.

Printed in the United States of America.

ISBN 1-57590-262-1

Reproduction of contents in whole or part or transfer into electronic or photographic storage without permission of copyright owner is expressly forbidden.

Neither NACE International, its officers, directors, nor members thereof accept any responsibility for the use of the methods and materials discussed herein. No authorization is implied concerning the use of patented or copyrighted material. The information is advisory only, and the use of the materials and methods is solely at the risk of the user.

Acknowledgments

It is amazing how much a person can learn from colleagues in the wonderful world of protective coatings. Such has been the case as I set out once more to update and expand the NACE International book, Corrosion Prevention by Protective Coatings. I would be remiss in my duties if I did not mention several people who have been a tremendous influence on my career and in particular in providing valuable information and technology for this Third Edition of what is commonly known as The Munger Book.

First of all is **Charles G. Munger**, “Chuck” as he is fondly remembered. He was my mentor when I first started out in the protective coatings industry, as well as a true friend.

Carl Angelof and **Todd Williams** of Bayer Material Sciences for some much needed new information on polyurethanes, polyureas, and polyaspartics.

Pete Englebert of Job Safety Associates, Inc. for his excellent revision and update of Chapter 16, “Safety.”

Hasan Sabri of Kuwait Oil Company for almost single handedly guiding me through the creation of the new Chapter 23, “Pipeline Coatings and Linings.”

Terry Greenfield of Corrometric Services, Inc. for his excellent Chapter 21, “Computer-Assisted Coatings Project Management Programs.”

John Kelly of Akzo Nobel for all his expertise in anti-fouling and foul release coatings contained in Chapter 22, “Coatings for Marine Vessels.”

Alex Szokolic and **R.A. Francis**, Australian colleagues, for their broad knowledge of the history and development of inorganic zinc coatings.

All of the students in NACE Coating Inspector Program (CIP) and Protective Coatings Specialist courses that I have taught over the years. I learned so much from their real-world practical experience.

Last, but certainly foremost in my thoughts, is **Mary Ann Vincent**, my lovely wife since 1952 for her love and patience when I was cranky and short-tempered while grinding away at the computer on this, my last update and revision of Corrosion Prevention by Protective Coatings.

It is my fervent hope that someone will take up the gauntlet at some point in the future to make new updates and revisions as new coatings technology becomes a reality.

NACE International
15835 Park Ten Place, Houston, TX 77084 • +1 281-228-6200 •
www.nace.org

Contents

[Corrosion Prevention by Protective Coatings](#)

[Acknowledgments](#)

[Author's Preface for the Third Edition of
Corrosion Prevention by Protective Coatings](#)

[Chapter 1](#)

[Introduction to Corrosion](#)

[Introduction](#)

[Historical Background](#)

[Types of Coatings](#)

[The Finished Product](#)

[The Development of Protective Coatings](#)

[The Future of Protective Coatings](#)

[Chapter 2](#)

[Corrosion as Related to Coatings](#)

[Corrosion of Materials Other Than Metal](#)

[Early Corrosion Studies](#)

[Fundamentals of Corrosion](#)

[Galvanic Corrosion](#)

[Chemical Corrosion](#)

[Mill Scale](#)

[Filiform Corrosion](#)

[Pitting Corrosion](#)

[Corrosion Under Insulation](#)

[Atmospheric Corrosion](#)

[Methods of Corrosion Control](#)

[Chapter 3](#)

[Essential Coating Characteristics](#)
[Coating Function](#)
[Essential Coating Properties](#)

[Chapter 4](#)

[Coating Fundamentals](#)
[Basic Coating Concepts](#)
[The Coating System](#)
[Basic Coating Formation](#)
[Coating Component Functions](#)
[Basic Coating Components](#)

[Chapter 5](#)

[Corrosion-Resistant Organic Coatings](#)
[Natural Air-Oxidizing Coatings](#)
[Vinyl Organosols and Plastisols](#)
[Co-Reactive Coatings](#)
[100% Solids Coatings](#)

[Chapter 6](#)

[Corrosion-Resistant Zinc Coatings](#)
[Protection by Zinc Coatings](#)
[Application of Zinc Coatings](#)
[Zinc Dust Coatings](#)
[Organic Zinc-Rich Coatings](#)
[Characteristics of Organic Zinc-Rich Coatings](#)
[Inorganic Zinc Coatings](#)
[Development of Inorganic Zinc Coatings](#)
[Composition of Inorganic Zinc Coatings](#)
[Pigmentation](#)
[Types of Inorganic Zinc Coatings](#)
[Advantages of Inorganic Zinc Preconstruction Primer](#)
[Single Package Inorganic Zinc Coatings](#)
[Characteristics of Inorganic Zinc Coatings](#)
[Types of Zinc-Rich Coatings](#)
[Comparison of Zinc-Rich Coatings](#)
[Topcoating](#)
[Comparison Summary](#)

[ANNEX 6A](#)

[A Short History of Water-Based High-Ratio Potassium Silicate Inorganic Zinc Coatings](#)

Early History

Chapter 7

Structural Design for Coating Use
Principle of Design for Coating Use
Interior and Exterior Design
Coating Problems Related to Design
Summary

Chapter 8

The Substrate—Importance to Coating Life
Types of Substrates
Types of Contamination
Summary

Chapter 9

Surface Preparation
Introduction
Types of Adhesion
Surface Preparation Objectives
Development of Surface Preparation Techniques
Types of Contamination
Types of Surface Preparation
Concrete Surfaces
Other Influences on Surface Preparation Selection

Chapter 10

Application of Coatings
The Type of Coating
Preparation for Coating Application
Application Methods
Application Problem Areas
Cost of Application

ANNEX 10A

Training and Certification of Application Specialists

Chapter 11

Coatings for Concrete
Introduction
Properties of Concrete
Composition of Concrete
Problems in Coating Concrete
Properties Required for Coatings Used on Concrete

[Reasons for Coating Concrete](#)
[Types of Coatings for Concrete](#)
[Surface Preparation of Concrete Prior to Coating](#)

[Chapter 12](#)

[Coating Selection](#)
[Introduction](#)
[Considerations in Coating Selection](#)
[Evaluating Operating Conditions](#)

[Chapter 13](#)

[Coatings and Cathodic Protection](#)
[Introduction](#)
[Cathodic Protection](#)
[Coatings](#)
[Consequences of Poor Coating Selection](#)
[Testing](#)
[Summary](#)

[Chapter 14](#)

[Coating Failures](#)
[Introduction](#)
[Specification-Related Failures](#)
[Formulation-Related Failures](#)
[Failures Due to Coating Selection](#)
[Repairing and Recoating](#)
[Substrate-Related Failures](#)
[Surface Preparation-Related Failures](#)
[Application-Related Failures](#)
[Design-Related Failures](#)
[Adhesion-Related Failures](#)
[Failures Due to Exterior Forces](#)
[Summary](#)

[Chapter 15](#)

[Coating Repair and Maintenance](#)
[Introduction](#)
[Primary Repair Considerations](#)
[Repair of Failures](#)
[Repair of Coatings](#)
[APPENDIX 15A^{\(1\)}](#)
[Procedures for Adhesion Test^{\(2\)}](#)

[Apparatus and Materials](#)

[Procedure](#)

[Discussion](#)

[Chapter 16](#)

[Safety](#)

[Introduction](#)

[Changes in the Coating Industry](#)

[Primary Hazards](#)

[Health Hazards](#)

[Summary](#)

[APPENDIX 16A](#)

[APPENDIX 16B](#)

[Introduction](#)

[Steps to Improve Painter Safety](#)

[Chapter 17](#)

[Specifications](#)

[Parts of a Specification](#)

[General](#)

[Application](#)

[Chapter 18](#)

[Inspection and Training](#)

[Variables Involved in Quality Control](#)

[Types of Coating Inspectors](#)

[What Should a Qualified Inspector Know?](#)

[Areas of Coating Inspection](#)

[Chapter 19](#)

[Typical Uses of High-Performance Coatings](#)

[The Chemical Industry](#)

[Inorganic Chemical Plants](#)

[Organic Chemical Plants](#)

[Pulp and Paper](#)

[The Mining Industry](#)

[The Steel Industry](#)

[The Power Industry](#)

[The Food Industry](#)

[Sewage Treatment](#)

[The Transportation Industry](#)

[Coatings Under Thermal Insulation](#)

Chapter 20

Elastomeric (Rubber) Linings

Curatives and Vulcanizing

Pigments

Types of Rubber Linings

Vessel Design

Surface Preparation

Cure

Safety

Reference Documents and Standards

Chapter 21

Computer Assisted Coatings Program Management

Introduction

The Process

Project Specification

Management Systems

Describing the Program Facilities

Grading Systems

Bringing Data Together for Management Action

Planning and Budgeting

Monitoring Effectiveness of Corrosion Prevention Systems

Summary

Reference

Bibliography

Acknowledgment

Chapter 22

Coatings for Marine Vessels

Introduction

Abrasion-Resistant Coatings

Antifoulings and Foul Release Coatings

Ballast Tank Linings

Cofferdam and Void Coatings

Deck Coatings—Including Heli-Deck Surfaces

Hull Coatings—Freeboard Area

Potable Water Tank Linings

Shop Primers

Universal Primers

Zinc-Rich Coatings

[Organic Primers and Tie-Coats](#)
[Heat-Resistant Coatings](#)
[Spray Metallizing Process \(Thermal Spray\)](#)
[Maintenance Painting Programs](#)
[Shipboard Corrosion Assessment Training \(S-CAT\)](#)

[Chapter 23](#)

[Pipeline Coatings and Linings](#)
[Introduction](#)
[Desirable Characteristics of External Pipeline Coatings](#)
[Typical Factors to Consider When Selecting an External Pipeline Coating](#)
[Coating Systems for Buried Pipes](#)
[FBE](#)
[Three-Layer High-Density Polyethylene/Polypropylene](#)
[High-Build Polyurethane Coatings](#)
[High-Build Epoxy Coatings](#)
[Coating Application—Field Joints](#)
[Coating of FBE Joints and Fittings](#)
[Underground Pipe Hot Polyurethane Foam Insulation](#)
[Inspection](#)
[Summary](#)

Contents