Cursos Nace International

CORROSION CONTROL IN THE REFINING INDUSTRY

Member Price, 2000 Euros
NonMember Price, 2150 euros

Lenguaje español: a través de la plataforma zoom
Course Topics

The following topics are included in *Corrosion Control in the Refining Industry*:

- Corrosion and Other Failures
- Crude Distillation and Desalting
- Fluid Catalytic Cracking Unit
- Cracked Light Ends Recovery (CLER) Units
- Hydrofluoric Acid Alkylation Units
- Sulfuric Acid Alkylation Units
- Corrosion in Hydroprocessing Units
- Catalytic Reforming Units
- Delayed Coking Units
- Amine Treating Units
- Sulfur Recovery Units
- Process Additives and Corrosion Control
- Corrosion Monitoring Methods in Refineries
- Refinery Injection Systems
- Materials of Construction for Refinery Applications
- Refinery Operations and Overview
- Failure Analysis in Refineries

Chapter 1: Corrosion and Other Failures
Introduction .
Low-Temperature Refinery Corrosion
Low-Temperature Corrosion Principles
Corrosion Rates and Polarization
Temperature and Concentration
Low-Temperature Conditions.
High-Temperature Refinery Corrosion
High-Temperature Corrosion Principles.
Linear Rate Law
Parabolic Rate Law .
High-Temperature Conditions .
Corrosion/Failure Mechanisms.
Metal Loss—General and/or Localized Corrosion.
Galvanic Corrosion
Pitting.
Crevice Corrosion
Intergranular Attack.
Erosion-Corrosion.
Hydrogen Chloride.
Ammonium Bisulfide (NH4HS) Carbon Dioxide.
Process Chemicals.
Organic Chlorides
Aluminum Chloride.
Sulfuric Acid
Hydrofluoric Acid.
Phosphoric Acid.
Phenol (Carbolic Acid)
Amines.
Atmospheric (External) Corrosion.
Corrosion Under Insulation (CUI)
High-Temperature Sulfide Corrosion (Without Hydrogen Present)
High-Temperature Sulfide Corrosion (With Hydrogen)
Naphthenic Acid Corrosion.
High-Temperature Oxidation.
Stress Corrosion Cracking (SCC)
Chloride Stress Corrosion Cracking (CISCC).
Alkaline Stress Corrosion Cracking (ASCC).
Carbonic Acid (Wet CO2)
Polythionic Acid Stress Corrosion Cracking (PTASCC)
Ammonia Stress Corrosion Cracking (NH3 SCC).
Wet H2S Cracking
Hydrogen Blistering.
Sulfide Stress Cracking (SSC)
Hydrogen Induced Cracking (HIC)
Stress Oriented Hydrogen Induced Cracking (SOHIC).
Hydrogen Cyanide (HCN)
SCC Prevention.
Inspecting for Wet H2S Damage.
High-Temperature Hydrogen Attack (HTHA).
Metallurgical Failures.
Grain Growth
Graphitization
Hardening
Sensitization.
Sigma Phase.
885°F (475°C) Embrittlement.
TemperEmbrittlement
Liquid Metal Embrittlement (LME).
Carburization
Metal Dusting
Decarburization
SelectiveLeaching
Mechanical Failures.
Incorrect or Defective Materials
Mechanical Fatigue.
Corrosion Fatigue
Cavitation Damage.
Mechanical Damage
Overloading
Overpressuring.
BrittleFracture
Creep.
Stress Rupture.
Thermal Shock.
Thermal Fatigue.
Other Forms of Corrosion.
BoilerFeedWaterCorrosion
Steam Condensate Corrosion.
Cooling Water Corrosion.
Fuel Ash Corrosion.

**Chapter 2: Crude Distillation and Desalting**

Introduction.
Sources of Crude Oil.
Composition of Crude Oil.
Remaining Constraints
More about Crude Oil Composition
Crude Oil Pretreatment.
Desalting.
Preflash
Crude Distillation Unit.
Operation of a Crude Distillation Unit
Corrosion in Crude Distillation Units.
Columns.
Exchangers and Piping.
Fired Heaters.
Other Corrosion Combating Measures Blending.
Desalting.
Caustic Addition.
Overhead pH Control.
Corrosion Inhibitor.
Water Washing.
Corrosion Monitoring in Crude Units. Water Analysis (Overhead Corrosion Control)
Hydrocarbon Analysis
Corrosion Rate Measurement.
On-Stream, Non-Destructive Examination
Optional Team Exercise

**Chapter 3: Fluid Catalytic Cracking Units**
Introduction.
Hardware.
Riser/Reactor
Regenerator.
Flue Gas System.
Fractionator
Corrosion Control in FCC Units
Materials of Construction
Damage Mechanisms and Suitable Materials
Reactors
Regenerators.
Catalyst Transfer Piping System.
Reaction Mix Line, Main Fractionator, and Bottoms Piping.
Flue Gas Systems.
Inspection and Control Considerations
High-Temperature Oxidation
High-Temperature Sulfidation (H2S Attack) High-Temperature Carburization.
Polythionic Acid Stress Corrosion Cracking CatalystErosion
Feed Nozzle Erosion.
Refractory Damage.
High-Temperature Graphitization.
SigmaPhaseEmbrittlement
885°F (475°C) Embrittlement.
CreepEmbrittlement
High-TemperatureCreep
Thermal Fatigue.
OptionalTeamExercise

**Chapter 4: Cracked Light Ends Recovery Units**
CLER Process Description
Materials of Construction
Columns
Exchangers
Corrosion Problems
Corrosion
Hydrogen Induced Damage
Inspection Techniques for Hydrogen-Induced Damage
Prevention and Repair Techniques. Ammonia Stress Corrosion Cracking
Carbonate Stress Corrosion Cracking. Fouling/Corrosion of Reboiler Circuits
Corrosion Control Measures
  . Water Washing
Polysulfide Injection
Corrosion Inhibitors .
Corrosion Monitoring
Hydrogen-Activity Probes .
Chemical Tests .
Corrosion Probes.

**Chapter 5: Hydrofluoric Acid Alkylation Units**
Introduction .
HF Alky Process Description Materials of Construction .
Columns .
Exchangers .
Piping .
Bolting
Corrosion Problems
Corrosion
Hydrogen Induced Damage .
InspectionandMitigation
Corrosion Control Measures .
Corrosion Monitoring .
Corrosion Probes.

**Chapter 6: Sulfuric Acid Alkylation Units**
Introduction
Process Description .
Reaction Section
Treating Section
Fractionation Section
Refrigeration Section Materials of Construction .
Materials and Corrosion Problems .
Sulfuric Acid Corrosion .
Acid Concentration .
Acid Temperature and Velocity.
Acid Dilution .
Hydrogen Grooving .
Feed Contaminants .
Acid and Neutral Esters
Acid Esters
Neutral Esters .
Acid Carryover .
Corrosion Under Insulation .
Fouling Problems
Corrosion Control Measures
Chapter 7: Hydroprocessing Units

Introduction
Hydroprocessing
Hydrotreating
Hydrocracking
Variations on Hydroprocessing
Types of Corrosion Common in Hydroprocessing Units
High-Temperature Hydrogen Attack
High-Temperature H2S Corrosion – With Hydrogen Present
High-Temperature H2S Corrosion – With Little or No Hydrogen Present
Naphthenic Acid Corrosion
Ammonium Bisulfide Corrosion
Chloride Stress Corrosion Cracking (SCC)
Failures Often Happen After Startup
Additional Considerations with Stainless Steel
Polythionic Acid (PTA) Stress Corrosion Cracking
Stainless Steels Used to Prevent PTA
Other Methods to Prevent PTA SCC
Wet H2S Cracking
Sulfide Stress Cracking (SSC)
Hydrogen Induced Cracking (HIC) and Stress-Oriented Hydrogen Induced Cracking (SOHIC)
Material Property Degradation Mechanisms
Temper Embrittlement
Hydrogen Embrittlement
Selection of Materials
Reactor Loop – General
Reactor Feed System
Reactor Feed Furnaces
Reactors
Reactor Effluent System
Reactor Effluent – Distillation Feed Exchangers
Chapter 8: Catalytic Reforming Units

Introduction
Octane Number (RON)
Catalyst
Catalytic Reforming Processes
Catalytic Reformer, Semi-Regenerative Reactor Design
Corrosion Phenomena in Catalytic Reformers
High Temperature Hydrogen Attack (HTHA)
Stress Corrosion Cracking
Materials of Construction
Reactors
Exchangers and Piping
Fired Heaters and Other Equipment
Corrosion Control
Corrosion Monitoring
Inspection in Catalytic Reformers

Chapter 9: Delayed Coking Units

Introduction
Equipment and Operation of the Delayed Coking Unit
Corrosion and Other Problems in Delayed Coking Units
High-Temperature Sulfur Corrosion.
Naphthenic Acid Corrosion
High-Temperature Oxidation/Carburization/Sulfidation
Decoking Heater Tubes
Erosion-Corrosion
Aqueous Corrosion
Corrosion Under Insulation (CUI)
Thermal Fatigue, and Temper Embrittlement of Cr-Mo Steels
Inspection of Coking Units
General Inspection
Coke Drum Inspection

Chapter 10: Amine Treating Units

Introduction
Types of Amines Used
Refinery Amine Process Description
Tail Gas Units
Corrosion Phenomena
Corrosive Species
Chapter 11: Sulfur Recovery Units

Introduction

Sulfur Recovery Units

Sulfur Chemical Reactions

Sulfur Recovery Process.

Tail Gas Treating Unit

Incinerator

Cold Bed Adsorption (CBA) Unit

Corrosion Mechanisms

Sulfidation of Carbon Steels

Sour Environment Corrosion

Weak Acid Corrosion

Corrosion of Claus Units by System

Feed Gas System.

Corrosion Concerns

Mitigation of Corrosion

Reaction Furnace and Waste Heat Exchanger Systems

Corrosion Concerns

Mitigation of Corrosion

Inspections in the Reaction Furnace and Waste Heat Exchanger System

Claus Reactors, Condensers, and Reheat System

Corrosion Concerns

Mitigation of Corrosion

Inspections in the Claus Reactors, Condensers, and Reheat System

Liquid Sulfur Rundown Lines and Storage System

Corrosion Concerns

Mitigation of Corrosion

Inspections in Liquid Sulfur Rundown Lines and Storage System

Corrosion of CBA Units

Corrosion Concerns

Mitigation of Corrosion

Inspection of CBA Reactors, Condensers, and Piping

Corrosion of Tail Gas Treating Units

Burner and Mixing Chamber

Tail Gas Reactor and Waste Heat Exchanger

Water Quench and Recirculation Blower System

H2S Adsorption System

Corrosion in the Incinerator System

Chapter 12: Refinery Injection Systems
Chapter 13: Process Additives and Corrosion Control

Introduction
Factors Affecting Corrosion
Acids
Temperature
Pressure.
Flow
Turbulence
Material Selection
Methods to Mitigate Corrosion
Desalting and Caustic Injection
Water Washing
. Acid Neutralization.
Barrier between Metal and Environment Chemicals Used to Combat Corrosion .
FilmingAmmones
Filmer Formulation
FilmerApplication
TreatRates
Monitoring Filmer Performance
Neutralizing Amines
Polysulfides
Naphthenic Acid Corrosion Inhibitors .
Application of Corrosion Inhibitors

Chapter 14: Corrosion Monitoring in Refineries

Introduction
Uses of Corrosion Monitoring
Corrosion Monitoring Techniques.
Corrosion Coupons
Electrical Resistance Monitoring
Electrochemical Corrosion Monitoring  Linear Polarization Resistance Potential Monitoring
Zero Resistance Ammetry (ZRA)
  . ElectricalImpedanceSpectroscopy(EIS)
Electrochemical Noise (EN)
Hydrogen Flux Monitoring.
A Comprehensive Corrosion Monitoring Program
CorrosionMonitoringSites
Corrosion Monitoring in Specific Process Units
Atmospheric Distillation Unit (ADU)
Vacuum Distillation Unit (VDU)
Fluid Catalytic Cracking Unit (FCCU) Amine Treating Unit (ATU)
Sour Water Stripper Units (SWSU)
Sulfuric Acid Alkylation Unit (SAU)
Automated On-Line Monitoring.

Chapter 15: Materials of Construction for Refinery Applications
The Role of the Corrosion Engineer Problem Definition
Corrosion Failures
Corrosion Testing Methods
Materials Selection Approach
Using Professional Consultants  . Specifying Materials
NationalStandards
CompanyStandards
What the Designer Should Remember When Writing Specifications
Questions the Designer Should Ask to Control Quality
FitnessforService
Refinery Materials of Construction
Introduction
KilledSteel
Steels.
Carbon Steel
C-MoSteels
Low-AlloySteels
Cr-MoSteels
NickelSteels
Stainless Steels
Martensitic Stainless Steels
Ferritic Stainless Steels
Austenitic Stainless Steels
Precipitation Hardening Stainless Steels
Duplex Stainless Steels
Specialty Stainless Steels
Cast Irons
Gray Cast Irons
Ductile Irons
High-Silicon Cast Irons
Nickel Cast Irons
Other Metals and Alloys
Copper and Its Alloys
Nickel Alloys
Aluminum
Titanium and Its Alloys
Non-Metallic Materials.
Refractories
Plastics
Thermosetting Resins
Heat Treatment
Normalization
Annealing
Quenching.
Stress Relieving
Solution Heat Treatment
Specialized Heat Treatments
What the Designer Should Know About Heat Treatments.
Heat Treatment Verification.
Heat Treatment for Welds.
Preheat
Postweld Heat Treatment.
Normalizing
Welding
The Nature of Welding.
Welding Decisions
Welding Processes
Shielded Metal Arc Welding (SMAW)
Gas Metal Arc Welding (GMAW)
Gas Tungsten Arc Welding (GTAW)
Submerged Arc Welding (SAW)
Welding Procedures and Welder Qualification
Inspection of Welding Electrodes and Filler Metal

**Chapter 16: Refinery Operations and Overview**
Introduction
Refinery Operating Objectives
Refining Process Overview
Process Interactions with

**Chapter 17: Failure Analysis in Refineries**
Introduction

Procedural Approach and Test Methods

Background Information

Initial Examination

Nondestructive Testing.

Surface Deposit Analysis

Field Metallographic Replication (FMR)

Hardness Testing

Chemical Analysis

Magnetic Particle Inspection (MPI)

Wet Method.

Dry Method

Dye Penetrant Testing (PT)

Sectioning.

Macroscopic Examination of Fracture Surfaces.

Microscopic Examination

Fracture Appearance

Ductile Fracture

Brittle Fracture

Fatigue Fractures

Corrosion

Stress Corrosion Cracking

Creep Rupture Failures

Additional Testing and Analysis.

Mechanical Testing

Application of Fracture Mechanics Root Cause Analysis.

Recommendations