COURSE OVERVIEW FE0261
Basic Corrosion
(E-Learning Module)

Course Title
Basic Corrosion
(E-Learning Module)

Course Reference
FE0261

Course Format & Compatibility
SCORM 1.2. Compatible with IE11, MS-Edge, Google Chrome, Windows, Linux, Unix, Android, IOS, iPadOS, macOS, iPhone, iPad & HarmonyOS (Huawei)

Course Duration
30 online contact hours
(3.0 CEUs/30 PDHs)

Course Description

This E-learning course is designed to provide participants with a basic overview of corrosion. It covers the nature concept and mechanism of corrosion; the various types of corrosion; the corrosion inspection and monitoring; the manifestations of corrosion, electrochemical attack, electrochemical corrosion cell, general (uniform) corrosion, localized attack, pitting corrosion, etc.; the factors effecting galvanic corrosion; the selective leaching and control of intergranular corrosion; the typical face of a corrosion fatigue break in a sucker rod body and basic corrosion mechanisms; the effect of oxygen, carbon dioxide, hydrogen sulphide, temperature, pressure, velocity and pH; the variation of corrosion rate with pH, effect of dissolved solids, basic corrosion mechanisms and major causes of corrosion; and the causes of petroleum related failures, CO2 corrosion reactions and effect of CO2 partial pressure on corrosion rate.

During this course, participants will learn the API/SPEC 5A, 5AC, 5AX tubing and casing including CRA grades; the hydrogen sulfide partial pressure (bar), domain diagram for super 13Cr, SSC failure of downhole and oxygen in surface waters; the choke “bean” erosion by produced formation sand; the effect of pitting on penetration rate; the acid corrosion rates on alloys and increasing rate of penetration with pit development; the sulfate reducing bacteria and corrosion resistant alloys; and the cracking initiated at a stress riser, slow crack growth, fast crack growth

Course Objectives

Upon the successful completion of this course, participants will be able to:-

- Apply and gain a basic knowledge on corrosion
- Discuss corrosion covering the nature concept and mechanism
- Recognize various types of corrosion and employ corrosion inspection and monitoring
- Describe manifestations of corrosion, electrochemical attack, electrochemical corrosion cell, general (uniform) corrosion, localized attack, pitting corrosion and etc.
- Identify the factors effecting galvanic corrosion as well as carryout selective leaching and control of intergranular corrosion
- Recognize typical face of a corrosion fatigue break in a sucker rod body and basic corrosion mechanisms
- Determine what species cause corrosion in petroleum production including the effect of oxygen, carbon dioxide, hydrogen sulphide, temperature, pressure, velocity and pH
- Identify the variation of corrosion rate with pH, effect of dissolved solids, basic corrosion mechanisms and major causes of corrosion
- Discuss the causes of petroleum related failures (1970's study), CO2 corrosion reactions and effect of CO2 partial pressure on corrosion rate
- Describe API/SPEC 5A, 5AC, 5AX tubing and casing including CRA grades (ISO 13680)
- Determine hydrogen sulfide partial pressure (bar) and describe domain diagram for super 13Cr, SSC failure of downhole and oxygen in surface waters
- Illustrate choke "bean" erosion by produced formation sand including the effect of pitting on penetration rate
- Discuss the acid corrosion rates on alloys and increasing rate of penetration with pit development
- Identify sulfate reducing bacteria and corrosion resistant alloys
- Recognize cracking initiated at a stress riser, slow crack growth, fast crack growth

Who Should Attend

This course provides an overview of all significant aspects and considerations of basic corrosion for engineers, managers, inspectors, supervisors, salespersons and technicians and those who need a basic understanding of corrosion.

Course Certificate(s)

Internationally recognized certificates will be issued to all participants of the course.

Certificate Accreditations

Certificates are accredited by the following international accreditation organizations: -

- USA International Association for Continuing Education and Training (IACET)

  Haward Technology is an Authorized Training Provider by the International Association for Continuing Education and Training (IACET), 2201 Cooperative Way, Suite 600, Herndon, VA 20171, USA. In obtaining this authority, Haward Technology has demonstrated that it complies with the **ANSI/IACET 1-2013 Standard** which is widely recognized as the standard of good practice internationally. As a result of our Authorized Provider membership status, Haward Technology is authorized to offer IACET CEUs for its programs that qualify under the **ANSI/IACET 1-2013 Standard**.

  Haward Technology's courses meet the professional certification and continuing education requirements for participants seeking **Continuing Education Units** (CEUs) in accordance with the rules & regulations of the International Association for Continuing Education & Training (IACET). IACET is an international authority that evaluates programs according to strict, research-based criteria and guidelines. The CEU is an internationally accepted uniform unit of measurement in qualified courses of continuing education.

  Haward Technology Middle East will award **3.0 CEUs** (Continuing Education Units) or **30 PDHs** (Professional Development Hours) for participants who completed the total tuition hours of this program. One CEU is equivalent to ten Professional Development Hours (PDHs) or ten contact hours of the participation in and completion of Haward Technology programs. A permanent record of a participant's involvement and awarding of CEU will be maintained by Haward Technology. Haward Technology will provide a copy of the participant's CEU and PDH Transcript of Records upon request.

- British Accreditation Council (BAC)

  Haward Technology is accredited by the **British Accreditation Council** for **Independent Further and Higher Education** as an **International Centre**. BAC is the British accrediting body responsible for setting standards within independent further and higher education sector in the UK and overseas. As a BAC-accredited international centre, Haward Technology meets all of the international higher education criteria and standards set by BAC.

Training Methodology

This Trainee-centered course includes the following training methodologies:-

- Talking presentation Slides (ppt with audio)
- Simulation & Animation
- Exercises
- Videos
- Case Studies
- Gamification (learning through games)
- Quizzes, Pre-test & Post-test

Every section/module of the course ends up with a Quiz which must be passed by the trainee in order to move to the next section/module. A Post-test at the end of the course must be passed in order to get the online accredited certificate.

Course Fee

As per proposal

Course Contents

- Understanding of Corrosion – Unit 1 Corrosion (Element 1 Corrosion Basics)
- What is Corrosion – The Nature Concept
- Corrosion Mechanism
- Corrosion Mechanism – Corrosion Cell
- Corrosion Mechanism – Sacrificial Anode
- Atmospheric corrosion
- Form of Corrosion
- Uniform corrosion
- Pitting corrosion
- Galvanized corrosion
- Erosion corrosion
- Cavitation corrosion
- Fretting corrosion
- Inter – Granular corrosion
- Exfoliation corrosion
- De-alloying or selective leaching
- Stress corrosion cracking (SCC)
- Corrosion of the metal

- Corrosion of Alloy
- Corrosion inspection and monitoring
- Corrosion inspection and monitoring – How Does Corrosion Inhibition Work?
- Corrosion inspection and monitoring – Corrosion Inhibitor – Typical Injection Points
- Corrosion inspection and monitoring – Downhole Chemical Injection
- Corrosion inspection and monitoring – Injection into Flowlines
- Corrosion inspection and monitoring – Branch Tree
- Corrosion inspection and monitoring – Wellhead Injection
- Corrosion inspection and monitoring – Typical Single Pump Skid
- MANIFESTATIONS OF CORROSION
- Electrochemical Attack
- Electrochemical Corrosion Cell
- General (Uniform) Corrosion
- Localised Attack
- Pitting Corrosion
- Crevice (Underdeposit) Corrosion
- Mechanism of Crevice Corrosion
- Galvanic Series in Seawater
- Galvanic Attack
- Galvanic Corrosion
- Factors Effecting Galvanic Corrosion
- Selective Leaching
- Graphitic Corrosion
- Intergranular Corrosion
- Intergranular Attack Weld Decay
- Intergranular attack
- Control of Intergranular Corrosion
- Erosion - Corrosion
- Velocity Effect
- Erosion Corrosion - Condenser Tube Wall
- Cavitation
- Velocity Phenomena
- Environmental Cracking

- Stress Corrosion Cracking
- Hydrogen Blistering
- Hydrogen Induced Cracking
- Sulphide SCC
- Corrosion Fatigue
- Typical Face of a Corrosion Fatigue Break in a Sucker Rod Body
- Basic Corrosion Mechanisms
- Why Corrosion Occurs
- Galvanic Series
- How Corrosion Occurs
- Corrosion Cell
- How to Control Corrosion
- What Species Cause Corrosion in Petroleum Production?
- Effect of Oxygen
- Oxygen Corrosion
- Effect of Carbon Dioxide
- CO2 Corrosion
- CO2 Corrosion - Prediction
- Effect of Hydrogen Sulphide
- H2S Corrosion
- Bacterial Corrosion
- Bacterial Corrosion - SRB
- How Fast Will Corrosion Occur?
- Effect of Temperature on Corrosion
- Effect of Pressure
- Effect of Velocity
- Effect of pH
- The Variation of Corrosion Rate With pH
- Effect of Dissolved Solids
- Basic Corrosion Mechanisms
- Corrosion – Corrosion Basics
- Corrosion – Specialty Problems
- Corrosion Control
- Major Causes of Corrosion

- Other Factors
- Chemical Corrosion
- Corrosion Recognition
- 1970's Industry Study of Failures
- Causes of Petroleum Related Failures (1970's study)
- Corrosion Cell
- Steel loss at the Anode
- Corrosion Types
- CO2 CORROSION REACTIONS
- CO2 Partial Pressure
- Effect of CO2 Partial Pressure on Corrosion Rate
- CO2 Corrosion Isoplot
- Chloride Stress Cracking
- Stress Sulfide Corrosion
- API/SPEC 5A, 5AC, 5AX Tubing & Casing
- Domain Diagram for C110
- CRA Grades (ISO 13680 except *)
- Hydrogen Sulfide Corrosion
- H2S corrosion
- H2S & pH
- Hydrogen Sulfide Partial Pressure (bar)
- Domain Diagram for Super 13Cr
- SSC Failure of Downhole - Tubular String in Louisiana
- Crevice Corrosion
- O2 Corrosion
- Oxygen in Surface Waters
- Abrasion Increases Corrosion
- Choke "Bean" Erosion – by produced formation sand
- Example of Screen Erosion by Sand Opposite Perforation
- Velocity Range
- Corrosion and Velocity
- Maximum Velocities
- Tubing Design Velocities
- Corrosion: water in sweet gas

- Effect of pitting on penetration rate – Low mpy (mils per year)
- Acid Corrosion Rates on Alloys
- Increasing Rate of Penetration with Pit Development
- Welds
- CO2 Injection Materials
- Biological Corrosion
- Sulfate Reducing Bacteria
- Corrosion Resistant Alloys
- Erskine – Failure of 25Cr Duplex SS
- High Island – Failure of 13Cr Alloy
- Bacterial Corrosion
- Trench corrosion common from CO2 attack
- Severe CO2 corrosion
- Cracking initiated at a stress riser
- Slow crack growth
- Fast crack growth
- CO2 corrosion
- CO2 Corrosion on Pin End of Tubing, above the Coupling
- 7.0 Casing Collar
- 5” Casing Collar/Note Corrosion
- 5” Casing Parted
- Co2 corrosion in box, just past gap in coupling
- Corrosion on the housing of an ESP (electric submersible pump)
- Parted coupling – CO2 corrosion – note trenches and pits
- Severe O2 corrosion in a surface line, just downstream of a connection
- Galled Threads – physical damage
- CT Corrosion Problems
- Chrome pipe after acidizing with the proper inhibitor and a inhibitor intensifier
- Chrome pipe after acidizing with the marginal
- Chrome pipe after acidizing – no inhibitor
- Well Failure Statistics
- Acid Inhibitor Mixing
- Inhibitor Mixing
- Corrosion in Packer Fluids

- Electrochemical
- Galvanic Series in Sea Water
- Sacrificial anode (magnesium) from an offshore platform
- Controlling Corrosion
- Corrosion Films
- Chromium
- Tubular Selection Criteria
- Wear from rod string on tubing
- Comparison of API RP 14 E and SWRI Field Data
- Example: Effects of Sand Size on Threshold Velocity
- Comparison of Present Method and API RP 14 E
- Cathodic Protection - How it Works
- Sacrificial Anode System
- Impressed Current System
- Criteria of cathodic protection
- Current intensity needed for cathodic protection
- Internal + External
- Sacrificial Anode Systems
- Sacrificial Magnesium Anodes
- Sacrificial Zinc Anode
- Sacrificial Aluminium Anodes
- Impressed Current System
- Silicon Iron Anodes
- Solar Powered Cathodic Protection – Station
- Insulating Flange Kits
- Reference Electrodes
- Insulator Spacers for Casings
- Casing End Seals
- Zinc Ribbon
- Serial Dilution
- Sulphate Reducing Bacteria
- Corrosion Control and Inhibitor Types
- Conditions Necessary for Corrosion
- Control

- Cathodic Protection
- Definition
- Types of Inhibitor Used in the Oilfield
- How do Inhibitors Work?
- Inhibitor Chemistry
- Amide/Imidazolines
- Quaternary Ammonium Compounds
- Nitrogen Heterocyclics
- Salts of Nitrogenous Molecules with Carboxylic acids
- Phosphate Esters
- Polyoxyalkylated Amines
- New Chemistries
- New Chemistries - Green Inhibitors What is "Green"?
- New Chemistries - "Green" Inhibitor Research
- Inhibitor Formulations
- Classification of Inhibitors
- Inhibitor Properties
- Summary
- Application of Inhibitors
- Methods of Application
- Application Methods Oil Wells
- Continuous
- Continuous Treatment Through Small Bore Tubing
- Chemical Injection Valves
- Continuous Injection into Annulus Top
- Chemical Injection via the Gas Lift System
- Oil Wells - Continuous Major Points to Consider
- Squeeze
- Schematic of a Typical Inhibitor Squeeze Treatment in an Oil Well
- Diagram Representation of the Squeeze Treatment
- Oil Wells - Squeeze Treatment Major Points to Consider
- Batch
- Batch Treatment by Tubing Displacement
- Batch Treatment – Traditional and Weighted Inhibitor

- Chemical Injection Via Injection Valves
- Oil Wells - Batch Treatment Major Points to Consider
- Gas Wells
- Treatment of Gas Wells
- Gas Wells - Major Points to Consider
- Oil Gathering Pipelines
- Oil Pipelines
- Recommended Dosage
- Start - Up Programmes
- Environmentally Acceptable Corrosion Inhibitors
- Inhibitor Development
- Environmentally Acceptable Inhibitors
- Gas Gathering Pipelines
- Corrosivity of Sweet Gas Flowlines
- Gas Pipelines
- Recommendations
- Oil Transmission Lines
- Gas Transmission Lines
- Water Injection Systems
- Waterfloods - Source Water
- Causes + Cures
- Oxygen Scavengers - Performance
- Oxygen Scavengers - Products
- Baker Petrolite Oxygen Scavenger Product Selection
- Oxygen Scavenger - Dosages
- Protective Coatings
- Types of Coatings
- Wrapping & Sleeves
- Corrosion Control Techniques
- Surface Preparation
- Surface Profile
- Surface Cleanliness International Standards
- Surface Cleanliness
- Water Jetting

- Abrasive Blasting
- Grit Blasting
- Chemical Composition of Paints
- Painting Application
- Paint Application Techniques
- Spray Application
- Air Spray
- Airless Spray
- Electrostatic Painting
- Electrostatic Spray
- Painting System (Cycle)
- 3-Layer Paint System
- Pipeline Coating System
- Keys of Coating Success
- Corrosion Control Techniques - Protective Coatings
- Dew Point Measurement
- Key to Successful Painting
- Painting Data Sheet
- Coating Properties
- Paint Inspection
- Surface Cleanliness Inspection
- Tips and Handy hints
- Dilution
- Compatibility
- Injection points
- Storage
- Safety
- Application
- Common Misconceptions