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Corrosion Control, Monitoring & Prevention in Petroleum Industry Training program

Introduction:

Maintaining the ageing of metallic structures such as underground pipelines, vessels, and storage tanks is a challenge to the oil and gas industry worldwide. Understanding why and how corrosion, and corrosion control techniques work or fail can help the operator formulate appropriate strategy in managing the corrosion problems. This corrosion course will also provide participants with an understanding of why and how corrosion occurs, the metallurgical and environmental factors influencing pipelines corrosion, and practical methods of corrosion control and failure prevention to manage the pipelines corrosion problems. The course is particularly directed at inspection and maintenance engineers who are concerned with corrosion of the structures of petroleum production. This course covers both the fundamentals and practices in designing, operating and maintaining corrosion and corrosion control for petroleum metallic structures.

Who Should Attend?

Corrosion Control Engineers & Personnel, Process Engineers, Metallurgists, Inspection Personnel, Mechanical Engineers, Material Selection Personnel, Plant Contractors, Operations Engineers, Team Leaders & Supervisors, Maintenance Supervisors, Senior Plant Supervisors, Mechanical Engineers, Corrosion Control & Monitoring Systems Personnel, Oil and Gas Production Facilities Personnel, Chemists, Chemical Engineers, Technicians and Supervisors, Personnel who are / will be responsible for detecting, inspecting, monitoring, controlling corrosion in oil and gas piping, pipelines used in production operations and Personnel responsible for metallurgy, corrosion or the prevention of failures in plant and equipment



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Course Objectives:

By the end of this course delegates will learn about:

- Know the basics of corrosion mechanism
- Learn about the corrosion forms
- Microbial corrosion and its control
- Material selection, coating, and chemical inhibition
- Cathodic protection by galvanic anodes, and its design
- Cathodic protection by impressed current system
- Identify measurements in cathodic protection
- Cathodic protection, and interference problems
- Cathodic protection troubleshooting
- Understand testing & monitoring techniques
- Know the definition of corrosion and its principles
- Know about the eight forms of corrosion and best ways to prevent it
- Learn how cathodic protection works
- Understand the effectiveness of pipeline coatings
- Know the different type of pipeline coatings
- Carry out coating failures analysis
- Identify and understand the sacrificial anode cathodic protection
- Identify and understand the impressed current cathodic protection
- Know well the criteria for cathodic protection
- Gain deep knowledge on the instrumentation used for cathodic protection of underground pipelines
- Understand the importance of regular inspection and maintenance
- Conduct pipeline inspection using survey methods and evaluation techniques
- Learn the NACE standard on pipeline external corrosion direct assessment methodology



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Course Outline:

Fundamentals of Corrosion

- Why do metals corrode
- How do metals corrode
- General methods of corrosion control and prevention

Testing & Monitoring Techniques

- What is corrosion monitoring?
- The aims of corrosion monitoring
- What are the corrosion monitoring methods?
- Corrosion test objectives
- Significance of corrosion rate values
- Corrosion monitoring location & technique
- Design of corrosion monitoring location
- Conventional techniques of on-line corrosion monitoring
- Probe insertion / retrieving on- line
- Intelligent pipeline pigging

Cathodic Protection

- Introduction
- How it works
- Why it works
- How effective it is



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Sacrificial Anode Cathodic Protection

- Anode materials
- Anode design

Impressed Current Cathodic Protection

- Consumable ICCP anodes
- Permanent ICCP anodes
- Power sources, cables and connections

Criteria for Cathodic Protection: Instrumentation for Cathodic Protection of Underground Pipelines

- Reference potential devices
- Potential measuring instrument
- Soil resistivity test instruments
- Wall thickness and pit gages
- Current interrupters
- Test rectifiers
- Holiday detectors

Cathodic Protection of Underground Pipelines

- Electrical resistivity
- Resistance of ground connection
- Non-uniform electrolyte
- Groundbed design
- Long pipelines and pipe insulating joints



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Stray Current Corrosion and Methods of Prevention

- Stray current corrosion and electrolysis
- Practical stray current problems
- Interference from other CP installations

Pipeline Coatings and the Effectiveness of Coatings

- Specification
- Inspection
- Type of pipeline coatings
- Coating failures and analysis

Cathodic Protection and Coatings: Pipeline Inspection: Survey Methods and Evaluation Techniques

- Survey methods for pipeline not under cathodic protection
- Survey methods for pipeline under cathodic protection
- Overview of NACE Standard on Pipeline External Corrosion Direct Assessment Methodology

Corrosion Principles

- Introduction
- References and definitions
- References
- Definitions
- Why metals corrode
- Corrosion defined
- Metal ores
- Chemical free energy



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- Nature of corrosion reaction
- Corrosion by water
- Voltage source
- Electrical circuits
- Polarization
- Nature of metals
- Inhomogeneities in metal surfaces
- Effect of electrolyte composition
- Conductivity
- Hydrogen ion Concentration (pH)
- Dissolved gases
- Oxygen
- Carbon dioxide
- Hydrogen sulphide
- Chloride ions
- Physical variables
- Temperature
- Pressure
- Velocity
- Forms of corrosion
- Uniform corrosion
- Pitting corrosion
- Bimetallic corrosion
- Flow enhanced corrosion (erosion corrosion)
- Cavitation corrosion
- Intergranular corrosion
- Hydrogen induced failures
- Sulphide stress cracking
- Stress corrosion cracking
- Corrosion fatigue
- Microbiologically influenced corrosion (MIC)
- Oxygen corrosion



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- Sweet corrosion (CO_2)
- Sour corrosion (H_2S)

Attachments

- Free energies of metal oxides
- Galvanic series in sea water
- Galvanic corrosion material selection guide
- Corrosion cell
- Zinc-copper corrosion cell
- Electromotive force series
- Polarization curve
- Corrosion rate of steel vs. pH
- Corrosion rate of steel vs. O_2
- H_2S service induced cracking of steels
- Qualitative categorization of coupon corrosion rates for oil production systems
- Corrosion rate of steel vs. CO_2

Fundamentals of Corrosion Mechanisms

- Introduction
- Wet corrosion
- Electrochemical reactions
- Electrode potentials
- Polarization and corrosion rates
- Forms of wet corrosion
- Dry corrosion
- High-temperature oxidation
- Hydrogen sulfide corrosion
- Biological corrosion
- Influence of microorganisms



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- Control of corrosion caused by microorganisms
- Influence of macroorganisms
- Glossary
- References

Corrosion Monitoring Techniques

- Electrical resistance probes
- Electrochemical linear polarization method
- Corrosion test nipples (spools)
- Corrosion coupons
- Iron counts
- Corrosion products analysis
- Ultra sonic gauges for surface inspection
- Procedure for retrieving corrosion monitoring devices under pressure
- Identify and explain in detail the procedures and problems associated with coupons and probe retrieval and installation

Basics of Corrosion Prevention

- What is corrosion
- The consequences of corrosion
- Chemistry of corrosion
- Factors that control the corrosion rate
- Corrosion prevention
- Conditioning the metal
- Coating the metal
- Alloying the metal
- Conditioning the corrosive environment
- Removal of oxygen
- Corrosion inhibitors



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- Electrochemical control
- Cathodic protection

Fundamentals of Cathodic Protection

- Contents
- Mechanism of corrosion
- Electrochemical concept of corrosion
- Fundamental corrosion reactions
- Corrosion cells
- Galvanic corrosion
- Mechanism of cathodic protection
- Corrosion cells and cathodic protection
- Basic electrical concept
- Types of cathodic protection systems
- Sacrificial anodes
- Impressed current system
- General considerations
- Polarization and current required for cathodic protection
- Metal surface area
- Effect of pH on current requirement
- Effect of temperature
- Effect of oxygen
- Effect of relative movement between the structure and electrolyte
- Effect of soil salinity
- Effect of time on polarized potential
- Criteria of cathodic protection
- Potential criterion
- Polarization shift criterion
- Secondary effects of cathodic protection
- Change in pH
- Calcareous coating



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- Electro-osmosis
- Cathodic interference
- Direct current (DC) interference
- Mitigation of DC interference
- Alternating current (AC) interference
- Mitigation of AC interference
- Communication interference
- Safety considerations
- Glossary
- References

CP Principles: CP for Special Applications

- Cathodic protection of tank and vessel internals
- Introduction
- Design considerations
- Sacrificial systems
- Impressed current systems
- Monitoring CP performance
- CP design calculations

CP Attachments

- Cathodic protection tasks
- Explain the criteria of potential level requirements for protecting a buried carbon steel pipeline
- Explain the objective of cathodic protection technique and where it is applied
- Explain the effect of over protection on the coating of a buried structure
- Demonstrate the ability to carry out maintenance of CP system unsupervised and capable of solving technical problems on his own



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- Explain the various survey techniques, interpretation of measurements, suggesting corrective action required and reporting
- Get familiar with interference, stray current and can identify interference in the CP protected system
- Identify and explain in detail the hazards associated with cathodic protection