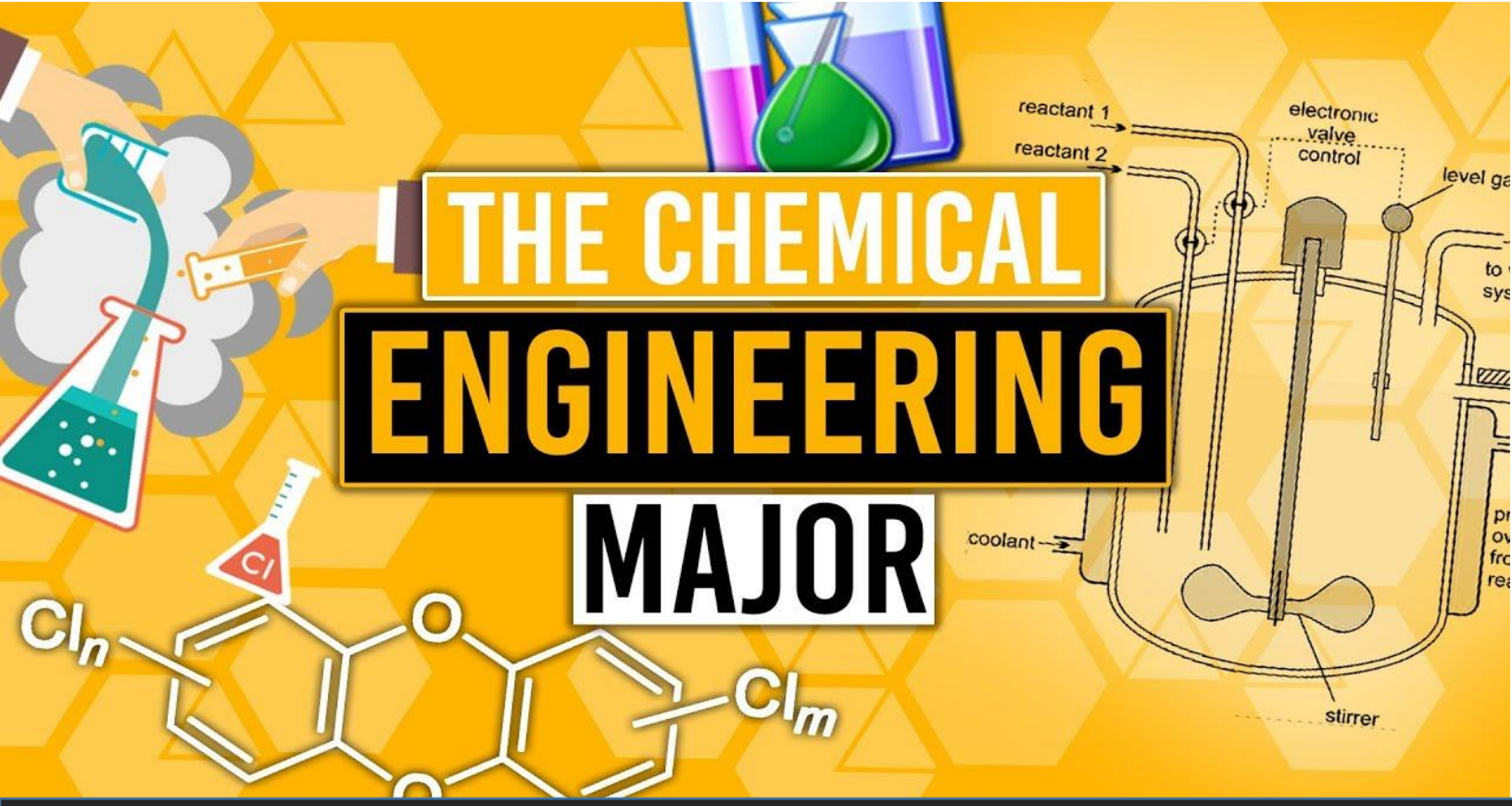

Advanced Cathodic Protection

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BTS
Training & Consultancy

Advanced Cathodic Protection

Introduction:

The course will teach the basics of chemistry and electrochemistry, introduce new insights into the mechanisms of CP based on literature, the effects of time variant interference (AC and DC), the relevance of backfill and mass transport and the consequences of these on the protection criteria in BS EN 12954 and ISO 15589-1. It will cover the mechanisms of AC corrosion and the threshold values in ISO 18086. It will address the mechanisms of stray current corrosion and relevance of these on the current revision of BS EN 50162. The design of CP buried pipeline systems will be addressed, including modelling of pipelines to mitigate the corrosion risks. Numerical modelling of specific risk scenarios will be undertaken, including high resistivity soils, anaerobic environments and poor bedding/backfill conditions.

New concepts based on established electrochemistry will be modelled. Their impact on CP criteria and on the mechanisms that lead to effective cathodic protection will be presented. Possible consequences of these new concepts on the present understanding of microbially influenced corrosion and stress corrosion cracking will be addressed. These theoretical presentations will be interspersed with practical exercises including CP measurements, coulometric oxidation according to ISO 18086, the modelling of corrosion potentials, the modelling of CP potentials including effects of bedding conditions and pH, calculation of voltage gradients at coating defects as a function of pH and its distribution

in soil, modelling of ac corrosion including the effects of geometric effects on corrosion rate. In addition, there will be exercises in the design of CP systems and mitigation of ac corrosion.

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 Engineers, Maintenance Supervisors, Senior Plant Supervisors, Mechanical Engineers, Corrosion Control & Monitoring Systems Personnel, Equipment Engineers, Maintenance Engineers and Planners, Team Leaders, Managers & Coordinators, Construction Coordinators, Technologists, Safety Officers, Maintenance Team Leaders & Engineers, Design Engineers, Service Company Representatives, Oil and Gas Production Facilities Personnel, Chemists, Chemical Engineers, Inspectors and Inspection Engineers & Supervisors, Technicians and Supervisors, Environmental Specialists, New Petroleum Engineers, Asset Management Personnel, Construction Engineers, Refinery Chemists, Chemical Engineers, 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.

Course Objectives:

By the end of this course, delegates will be able to:

- Have an in-depth technical knowledge of cathodic protection methodology
- Understand cathodic protection system design and the associated parameters
- Understand principles of corrosion and corrosion control
- Monitor and manage of CP protected structures
- Gain knowledge about the theoretical basis for selected types of corrosion why corrosion initiate and which elements that are of importance
- Have basic knowledge about hydrogen embrittlement including the influence of different factors
- Acquire detailed knowledge about cathodic protection and protective coatings
- Be able to use basic theory on practical problems
- Be able to plan/execute experiments and to report and communicate research results in a scientific way
- Be able to present acquired knowledge in a practical and understandable manner

Course Outline:

- Fundamentals of metallurgy
- Material selection
- Material/fluid compatibility
- topside/ subsea materials
- Fundamentals of corrosion
- Electrochemical reaction/ series
- Types of corrosion
- General or uniform corrosion
- Localized corrosion
- Galvanic corrosion
- Pitting corrosion
- Crevice corrosion
- HISC
- Corrosion control and prevention methods
- Inhibitors
- Selection and testing of inhibitors
- Inhibitor availability & inhibitor efficiency
- Introduction to cathodic protection (CP)
- Principles of cathodic protection
- Criteria for cathodic protection
- Impressed versus sacrificial
- Sacrificial anode cathodic protection (SACP)
- Requirements for SACP
- Anode materials
- Impressed current cathodic protection (ICCP)
- ICCP anodes

- Power sources
- Electrical connections
- Cathodic protection system design
- Anode resistances
- Coating breakdown factor
- Current densities
- Effect of temperature on CP design
- Review of DNV RP B401
- CP design calculations
- Cathodic disbonding and blistering
- Corrosion monitoring and management
- CP and concrete
- Cathodic protection of steel in concrete
- Ground bed design
- Current drain test
- Sacrificial anode system in soil
- Calcareous films
- Underground pipelines
- Cathodic protection of underground pipelines
- Potential decay along pipeline
- CP marine platforms
- Reference potential devices
- CP potential distribution
- Current interrupters
- Test rectifiers
- Holiday detectors
- Stray current corrosion and prevention methods
- Sources of stray current

- Effects of stray current on metallic structures
- Mitigation of interference effects
- Coating selection
- Pipeline coatings
- Characteristics of pipeline coatings
- Types of pipeline coatings
- Specification and inspection
- Coating failures
- Field joint coatings and applications
- Factory- applied vs. field- applied
- Cathodic protection and coatings
- Pipeline inspection: survey methods and evaluation techniques
- Overview of NACE standard on pipeline external corrosion direct assessment methodology
- Long range ultrasonic testing (LRUT)
- Advantages and limitations of LRUT
- Conventional UT vs. LRUT
- Introduction to CPCM technology
- Conventional current measuring methods vs. CPCM