

# MANAGING CORROSION IN THE OIL & GAS INDUSTRY



A 3-days intensive course by  
**Marcel Roche**

... a Corrosion Expert who has more than 37 years experience in the field of corrosion & cathodic protection.

Also an Author & co-author of about 80 papers presented at national & international levels. Most recent papers have been presented at NACE Conferences, Eurocorr's, SPE Conferences and BHR Conferences.

Is Corrosion eating away your critical equipments in your plant/asset?  
**Proper Corrosion Prevention & Cathodic Protection Methods  
can SAVE not only your \$\$\$, also LIVES!**

This course is specially designed for **oil & gas production, transportation and storage**. i.e. production of oil & gas using wells and surface facilities for separating fluids, injecting water, storage of oil, and all pipelines used for transportation of raw as well as commercial crude oil and gas.

The course discusses the major issues related to corrosion and its prevention, more especially in connection with Oil & Gas production and transportation facilities.

After addressing the challenges and describing the corrosion management and its relationship with inspection, the course will present the theory of electrochemical "wet" corrosion and its prevention methods (chemical treatments, coatings, cathodic protection). The practical cases of corrosion which may occur in this industry are described together with the prevention methods used.

At the end of this course, participants will obtain a good knowledge in corrosion management for non specialists or to improve it for those having initially some experience in the corrosion field.

Date :  
Time :  
Venue:

## *Who should attend?*

Participants should have basic knowledge in chemistry, electricity, oil & gas processes and equipment.

- ✓ Plant Management Team
- ✓ Project Management Team
- ✓ Inspector, Inspection Engineer
- ✓ Process Engineer, Designer
- ✓ Maintenance Engineer
- ✓ Fresh Corrosion/Material Engineer

Meanwhile, participants with basic knowledge on corrosion may achieve maximum benefit from the course.

For more information, please contact

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# MANAGING CORROSION IN THE OIL & GAS INDUSTRY

## Module 1

- ♦ **Challenges of Corrosion Management in the Oil & Gas industry**
  - Definition of corrosion, “wet” corrosion and others, consequences, costs, principles of corrosion management and relationship with inspection.
- ♦ **Materials and corrosion prevention methods**
  - Main materials used and their basic characteristics: carbon steels, various families of stainless steels, nickel alloys, copper alloys, titanium and aluminium alloys, plastics and composites.
  - Corrosion prevention methods: selection of materials, actions on design, physical and chemical treatments of the corrosive environments, coatings, cathodic and other electrochemical protection systems.

## Module 2

- ♦ **“Wet” corrosion**
  - Reminders of chemistry, electrochemistry, mechanisms of “wet” corrosion, main notions and laws: electrochemical potential, reference electrodes, Nernst series and law, thermodynamical approach (Pourbaix Potential-PH diagrams), Faraday’s law, kinetics approach (Potential-current diagrams), polarization curves, Evans diagrams.
  - Major forms of “wet corrosion”:
    - δ General corrosion.
    - δ Localized corrosions: galvanic corrosion between dissimilar metals and alloys and the way to prevent it when necessary, differential aeration corrosion, localized corrosions of passivated alloys in chloride containing environments
    - δ Complex corrosions: fatigue-corrosion, influence of biofilms, microbiologically influenced corrosion (MIC), influence of d.c. and a.c. stray currents and telluric currents and their mitigation.



## Module 3

- ♦ **Main families of internal corrosion in the Oil & Gas industry and their prevention**
  - CO<sub>2</sub> (and H<sub>2</sub>S) Corrosion: mechanism, prediction models, prevention and mitigation methods by the use of corrosion inhibition, pH stabilisation through recirculated hydrate prevention systems, stainless steels and other “Corrosion-Resisting Alloys” and non metallics. “Top-of-line corrosion” in hot acidic wet gas pipelines, its prevention and mitigation.
  - H<sub>2</sub>S cracking phenomena (“Sour service”): SSC (Sulphide Stress Cracking), HIC (Hydrogen Induced Cracking) and SOHIC (Stress Oriented Hydrogen Induced Cracking), how to predict the severity of environments and select the materials (ISO 15156/ NACE MR 0175).
  - “Microbiologically Influenced Corrosion” (MIC): mechanism, risks, prevention, monitoring and biocide treatments.
  - O<sub>2</sub> Corrosion: risks due to O<sub>2</sub> traces in process fluids, how to prevent corrosion in seawater circuits.

## Module 4

- ♦ **Monitoring of internal corrosion**
  - Water analysis, coupons, probes.
- ♦ **Corrosion-related inspection**
  - The principles of Risk-Based Inspection (RBI)
  - Some newer methods used for inspection such as Acoustic Emission
  - The use of Calipers for the inspection of well tubings and of intelligent pigs (“In-Line Inspection”) for pipelines
- ♦ **Paint systems and metallic coatings**
  - Challenges, main systems, major parameters, the specific case of bolts, the specific problems with offshore risers.

## Module 5

- ♦ **Cathodic Protection (CP) and associated coatings**
  - Theory and principles, favorable and detrimental consequences of cathodic electrochemical reactions, criteria for assessing the effectiveness.
  - Limitations: CP current shielding effect under disbanded coatings, electrical interferences, internal corrosion at isolating joints, blistering of sensitive paints, cathodic disbonding of coatings, hydrogen damage to sensitive materials, cathodic alkaline corrosion.
- ♦ **Basis on CP design**
  - Design parameters: current densities versus environments, coating breakdown factors.
  - Types of CP systems: Impressed Current CP systems (ICCP), Galvanic systems, comparative advantages and drawbacks of the two systems.
  - CP Design: fundamentals and basis for calculations

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## Module 6

### ♦ Main applications of Cathodic Protection

- structures in contact with soil: buried pipelines (including coatings and risks related to corrosion under disbondments), piping, plants, buried and above-ground tanks, well casings.
- Marine and offshore structures: marine activities, harbors, offshore pipelines, platforms and various structures used by the Oil & Gas industry such as FPSO's, deep water wellheads and manifolds.
- internal of apparatuses: separators, internal side of storage tanks and other types of equipment, seawater filters, water boxes of heat-exchangers.
- reinforced concrete structures: buried, immersed or air-exposed (specific technology)

## Module 7

### ♦ CP Measurements

- General on measurements for the verification of the effectiveness of CP systems. The problematic of the "Ohmic IR drop error" between reference electrode and the metallic surface to be checked.
- CP measurements on buried structures, especially onshore pipelines. "ON" and "ON/OFF" measurements. Problems related to the presence of stray or telluric currents. The use of probes (or coupons). Close Interval Potential Surveys (CIPS) and detection of coating defects using methods such as the Direct Current Voltage Gradient (DCVG). Routine measurements and specialized surveys.
- CP measurements on ships, offshore structures and pipelines. Routine measurements and monitoring carried out from the surface. Specialized surveys during inspection campaigns.
- Follow-up of CP effectiveness inside equipment.

## *Trainer's Background*

**Mr. Marcel Roche** has accumulated more than 37 years hands-on experience in the field of corrosion & cathodic protection. From a Mathematics Teacher to a Corrosion Engineer (17 years), and advanced to the Head of Inspection-Corrosion Department (15 years) and Coordinator for Static Equipment (5 years). Marcel's last held position was as the Corrosion Expert at the Technology Division of the Exploration & Production branch of Total.

### **Membership of Professional Bodies & Achievements**

- ✓ Certified level 3 (expert) in cathodic protection for land and marine application sectors with AFNOR Compétence scheme. AFNOR being the French Standardization Body.
- ✓ Examiner for certification examinations in cathodic protection organised by CEFRACOR / CFPC on behalf of AFNOR Certification, land and marine application sectors, levels 1, 2 and 3.
- ✓ COFRAC (French Accreditation Body) technical auditor in cathodic protection.
- ✓ Chairman of the "Cathodic Protection & Associated Coatings" Committee of CEFRACOR (Centre Français de l'Anticorrosion). Organisation of the CEFRACOR Aix-en-Provence Seminars in 1999, 2003 and 2006.
- ✓ Chairman of the Working Party on Cathodic Protection (WP 16) of the EFC (European Federation of Corrosion). Organisation of the Cathodic Protection sessions in the annual conferences Eurocorr's.
- ✓ Launcher and past Chairman of the « Corrosion in the Oil & Gas Industries » Committee of CEFRACOR.
- ✓ Member of standardisation working groups in cathodic protection (CEN TC219 WG1 for Buried applications, WG3 for Seawater applications, WG4 for Internal of apparatuses, Convenor of WG5 for Competence and Certification, ISO TC67 SC2 WG11 for Pipelines)
- ✓ Leader of standardisation working group for pipeline field joint coatings (ISO TC67 SC2 WG14-3).
- ✓ Member of NACE International; the National Association of Corrosion Engineers in the USA.
- ✓ Teacher in corrosion and cathodic protection topics, especially for TPA (Total Profs Associés), IFP Training (French Institute of Petroleum) and Institut de la Corrosion (subsidiary of KEMAB from Sweden).
- ✓ Implications in the R & D aspects of corrosion in Oil & Gas industry, mainly for development of a modelling software in cathodic protection (PROCOR) or data acquisition for seawater cathodic protection parameters including deep waters, definition of PHD's programmes in pipeline coatings (disbondment problems of 3-layer systems), corrosion risks under disbonded coatings, and cathodic protection (electrochemical parameters of steel in soils).
- ✓ Author or co-author of about 80 papers presented at national and international levels. Most recent papers have been presented at NACE Conferences, Eurocorr's, SPE Conferences and BHR Conferences and were dealing with onshore and offshore CP and coatings as well as more general corrosion topics mainly related to pipelines.