COURSE OVERVIEW FE0460-3D
Corrosion Inhibition Technology

Course Title
Corrosion Inhibition Technology

Course Date/Venue
September 02-04, 2024/Fujairah Meeting Room, Grand Millennium Al Wahda Hotel, Abu Dhabi, UAE

1.8 CEUs (18 PDHs) AWARD

Course Reference
FE0460-3D

Course Duration/Credits
Three days/1.8 CEUs/18 PDHs

Course Description

This practical and highly-interactive course includes various practical sessions and exercises. Theory learnt will be applied using our state-of-the-art simulators.

Effective corrosion inhibitor programs mean fewer equipment repairs, lower maintenance cost and less production downtime. In establishing corrosion treatment programs, it is essential to determine the most effective inhibitor for a given environment. In most cases, corrosion inhibitors are selected based on performance in the field.

Traditionally, inhibitors and various inhibition treatments are tried until a combination that reduces failures and their inherent costs is found. This is a costly and time consuming process.

This course will cover the aspects of corrosion inhibition and the industrial applications of inhibitors within the Process industry. The course deals with the electrochemical principles and chemical aspects of corrosion inhibition, such as stability of metal complexes, the Hammett equation, hard and soft acid and base principle, quantum chemical aspects and Hansch's model and also with the various surface analysis techniques, e.g. XPS, Auger, SIMS and Raman spectroscopy, that are used in industry for corrosion inhibition.

Case studies given in this course include: oil and gas wells, gas/oil separation plants, petroleum refineries, petrochemical plants, water cooling systems, acid systems and many more. Further, the course will cover economic and environmental considerations which are now of prime importance within Oil & Gas industry.

Course Objectives

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

- Apply and gain an in-depth knowledge on corrosion inhibitors
- Discuss the historical aspects of corrosion inhibition covering its purpose, economic considerations, safety considerations and behavior
- Explain electrochemical principles and chemical aspects of corrosion inhibition
- Carryout surface analysis and composition of inhibitor films including quality control of corrosion inhibitors
- Apply corrosion tests and determine inhibition of localized corrosion, inhibition of stress corrosion cracking and inhibition by macrocyclics and rare earth metal compounds
- Identify biocides, oxygen scavengers and expert system for corrosion control
- Recognize corrosion inhibition in oil and gas wells, gas/oil separation plant, refinery and petrochemical plants and pipelines and flowlines
- Describe inhibition in cooling water systems, inhibitors for acid systems and inhibitive protection of metals by organic coatings
- Determine corrosion inhibition of copper, economic considerations and environmentally-friendly inhibitors
- Apply proper selection of corrosion inhibitor for oil & gas industry
- Employ corrosion inhibition management and identify application window, process data, compositions and equipment
- Recognize chemicals, operations and operating range
- Carryout process assessment and corrosion analysis
- Define integrity operating window and corrosion inhibition (CI) test program

Exclusive Smart Training Kit - H-STK®

*Participants of this course will receive the exclusive "Haward Smart Training Kit" (**H-STK®**). The **H-STK®** consists of a comprehensive set of technical content which includes **electronic version** of the course materials, sample video clips of the instructor's actual lectures & practical sessions during the course conveniently saved in a **Tablet PC**.*

Who Should Attend

This course provides a wide understanding and deeper appreciation of corrosion inhibition for practicing corrosion engineers, process engineers, chemical engineers, chemists, R&D, R&T, petroleum engineers, production engineers, drilling engineers, utility engineers, water engineers, production supervisors, metallurgist, materials engineers, process operators and students of materials science, engineering and applied chemistry. Further, the course is essential for all laboratory chemists, scientists, analysts and other technical staff who are involved in analysis techniques of corrosion inhibitors.

Course Certificate(s)

Internationally recognized certificates will be issued to all participants of the course who completed a minimum of 80% of the total tuition hours.

Certificate Accreditations

Certificates are accredited by the following international accreditation organizations: -

- The International Accreditors for Continuing Education and Training (IACET - USA)

  Haward Technology is an Authorized Training Provider by the International Accreditors 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 2018-1 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 2018-1 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 Accreditors 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 **1.8 CEUs** (Continuing Education Units) or **18 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

All our Courses are including **Hands-on Practical Sessions** using equipment, State-of-the-Art Simulators, Drawings, Case Studies, Videos and Exercises. The courses include the following training methodologies as a percentage of the total tuition hours:-

30% Lectures
20% Practical Workshops & Work Presentations
30% Hands-on Practical Exercises & Case Studies
20% Simulators (Hardware & Software) & Videos

In an unlikely event, the course instructor may modify the above training methodology before or during the course for technical reasons.

Course Instructor(s)

This course will be conducted by the following instructor(s). However, we have the right to change the course instructor(s) prior to the course date and inform participants accordingly:

Dr. Mahmoud Hafez, PhD, MSc, BSc, **Senior Inspection Engineer** with over **20 years** of industrial experience within the **Petroleum**, **Oil** & **Gas** industries. His fields of specialization cover the areas of **Coating Inspection**, **Paintings & Coating** Technology, Plastic & Powder **Coating**, **Protective Coating Technology**, Coatings in Construction with Cathodic Protection (**CCCP**), **Coating & Thermal Insulation**, **Steel Pipes Protective Coatings**, **Steel & Composite**, **Mixing & Applications**, **Concrete Mixtures**, **Concrete Repair & Concrete Protection**, **Concrete Testing**, **Blasting & Painting**, **Abrasive Blasting**, **UHP Blasting**, **Blast Track Operator** Program, **Oxifree Technician** Program, Industrial **Spray** Application, **Inspection & Maintenance** of **Process Equipment**, **Asset Management**, **Set Building**, **Scaffold** Inspection, **Cathodic** Protection Systems, **Corrosion** Control & Corrosion Monitoring, **Metallurgy & Metallurgical** Processes, **Material** Selection, **Corrosion** Monitoring Prevention & Control, **Corrosion** Prevention & Control, Corrosion Management in Production/Processing Operations, **Corrosion** Prevention in Oil and Gas Industry, **Corrosion Inhibitor**, **Corrosion** Technology & Inspection, **Corrosion** Control in Gas, Oil & Water**, Corrosion & Corrosion** Protection, **Corrosion** Prevention, **Corrosion** Assessment, **Condition** Monitoring & Assessment, **Pipeline Corrosion** Inspection, **Pipeline** Design & Construction, **Pipeline** Engineering, **Pipeline** Integrity, **Pipeline** Operations & Maintenance. His wide range of industrial experience also covers **Cathodic Protection**, **Offshore Structure** & **Facilities**, **Onshore Facilities & Storage Tanks**, **Corrosion** Management & Monitoring and **Water Injection Treatment.**

Throughout his career life, Dr. Hafez has provided significant contributions to the companies he has worked with, having filled key positions such as being the **Freelance Consultant**, **Principle Engineer**, **Assistance General Manager**, **Materials and Corrosion Section Head**, **Senior Lead Material and Corrosion Specialist** and **Senior Chemical Water Treatment Engineer** for international companies such as Petrofac, Egyptian Maintenance Company, Engineering for the Petroleum and Process Industries and Metito Chemical Industries.

Dr. Hafez has **PhD** in **Corrosion Science and Engineering** from **University of Manchester (UK)** and **Master** & **Bachelor** degrees in **Chemical Engineering** from the **University of California** (**UK**) & **University of Riyadh (KSA)**. He is a **Corrosion Specialist** of the **National Association of Corrosion Engineers** (**NACE-USA**). Moreover, he is a **Certified Internal Verifier/Assessor/Trainer** by the **Institute of Leadership and Management** (**ILM**) and has further delivered numerous trainings, courses, seminars, conferences and workshops globally.

Course Fee

US$ 3,750 per Delegate + **VAT**. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

Accommodation

Accommodation is not included in the course fees. However, any accommodation required can be arranged at the time of booking.

Course Program

The following program is planned for this course. However, the course instructor(s) may modify this program before or during the course for technical reasons with no prior notice to participants. Nevertheless, the course objectives will always be met:

Day 1: ***Monday, 02nd of September 2024***

0730 – 0800	*Registration & Coffee*
0800 – 0815	*Welcome & Introduction*
0815 – 0830	***PRE-TEST***
0830 – 0900	***Corrosion Inhibition – Introduction & Historical Aspects*** *Common Methods of Corrosion Prevention ● The Purpose of Corrosion Inhibitors ● Economic Considerations ● Safety Considerations ● Forms of Corrosion ● Historical Aspects*
0900 – 0915	***An Overview of Corrosion Inhibition*** *General Aspects ● Adsorption of Inhibitors ● Stability of Inhibitors ● Behavior of Inhibitors in Acid Solutions ● Behavior of Inhibitors in Neutral Solutions ● Behavior of Inhibitors in Alkaline Solutions ● Behavior of Metal in Inhibition*
0915 - 0930	***Electrochemical Principles*** *Potential Sequence, Nernst Equation, The Electrical Double Layer, Free Energy, Tafel Plots ● Polarization Resistance & AC Impedance ● Instrumentation, Pourbaix Diagrams & Electrochemical Kinetics ● Mixed Potential Model of Corrosion ● Multiple Partial Process Corrosion Systems ● Potential & Polarization Measurements*
0930 – 0945	*Break*
0945 – 1100	***Chemical Aspects of Corrosion Inhibition*** *Stability of Complex Compounds ● The Hammett Equation Historical Aspects ● Quantum Chemical Consideration ● Hard & Soft Acids & Bases Principle in Corrosion Inhibition ● The Hansch Model in Corrosion Inhibition ● Some Industrial Applications of Metal Complexes*
1100 – 1130	***Surface Analysis & Composition of Inhibitor Films*** *Vacuum Considerations ● General Analytical Aspects of Surfaces ● Electron Spectroscopy ● Secondary Ion Mass Spectrometry (SIMS) ● Electron Microprobe Analysis ● Elucidation of the Nature of Inhibitor Films ● X-ray Diffraction Analysis ● Applications in Corrosion Inhibition ● Raman Spectroscopy ● Surface Enhanced Raman Scattering (SERS) Technique ● Optical Reflectance Spectroscopy ● Application of Reflective Fourier Transform Infrared Spectroscopy ● Application of Surface Analysis Techniques in the Study of Corrosion Inhibition Mechanisms*
1130 - 1230	***Quality Control of Corrosion Inhibitors*** *Nuclear Magnetic Resonance Spectroscopy ● Mass Spectroscopy ●Infrared Spectroscopy ● Liquid Chromatography ● High-pressure Liquid Chromatography*
1230 – 1245	*Break*
1245 – 1345	***Corrosion Tests*** *Simulated Long-term Laboratory Tests ● Corrosion Rate Expression ● Laboratory Studies*

1345 – 1420	***Inhibition of Localized Corrosion*** *Adsorption ● Influence of Environmental Factors ● Interactions during Adsorption ● Passivation of Metals ● Inhibition of Localized Corrosion*
1420 – 1430	***Recap*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today & Advise Them of the Topics to be Discussed Tomorrow*
1430	*Lunch & End of Day One*

Day 2: Tuesday, 03rd of September 2024

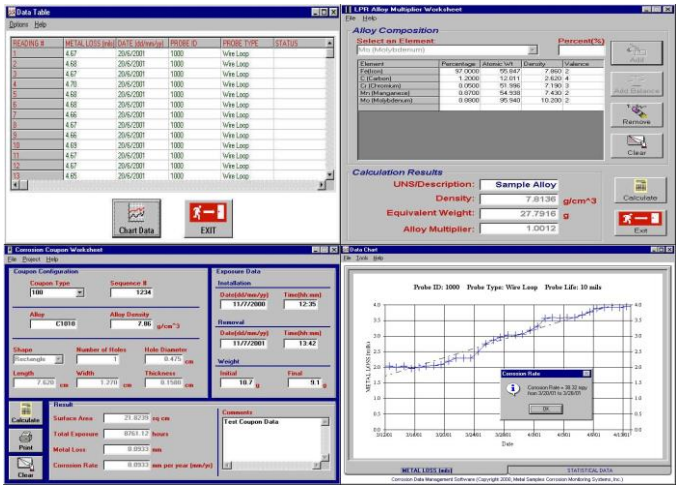
0730 – 0830	***Inhibition of Stress Corrosion Cracking*** *Inhibition due to the Influence on Local Cells ● Inhibition by Shift in Potential ● Inhibition of Ingress of Hydrogen into the Metal*
0830 – 0900	***Inhibition by Macrocyclics & Rare Earth Metal Compounds*** *Inhibition by Porphyrins ● Electrochemical Studies ● Phthalocynanines as Inhibitors ● Cathodic Inhibition by Rare Earth Metal Compounds ● Electrochemical Studies ● Film Characteristics ● Mechanism of Inhibition ● Corrosion Inhibition by Rare Earth Metal Salts*
0900 - 0930	***Biocides***
0930 – 0945	*Break*
0945 – 1030	***Oxygen Scavengers*** *Mechanism ● Inhibition by Oxygen Scavengers ● Catalysis*
1030 – 1130	***Expert Systems for Corrosion Control*** *Expert Systems for Corrosion Prevention ● General ES Projects ● Specialized ES Projects ● Cathodic Protection ● Cooling Water ● Diagnostic & Failure Analysis ● Inhibitors ● Material Selection ● Power Plants ● Petroleum Industries ● Reinforced Concrete ● Risk Analysis ● Expert System for Selection of Inhibitors ● Expert Systems*
1130 - 1230	***Corrosion Inhibition in Oil & Gas Wells*** *Oil Wells ● Anaerobic Corrosion ● Oxygen Induced Corrosion ● Impedance Spectroscopy ● Electrochemical Noise ● Gas Wells ● Inhibition in Gas Wells ● Downhole Applications*
1230 – 1245	*Break*
1245 – 1345	***Corrosion Inhibition in Gas/Oil Separation Plant*** *Inhibitor Selection ● Inhibitor Injection*
1345 – 1400	***Corrosion Inhibition in Refinery & Petrochemical Plants*** *Corrosive Conditions ● Aqueous Phase ● Corrosion of Steel & Copper Alloys ● Inhibition ● Organic Inhibitors*
1400 - 1420	***Corrosion Inhibition in Pipelines & Flowlines*** *Continuous Injection ● Batch Treatment ● Inhibitor Selection/Dosage ● Performance Monitoring*
1420 – 1430	***Recap*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today & Advise Them of the Topics to be Discussed Tomorrow*
1430	*Lunch & End of Day Two*

Day 3: **Wednesday, 04th of September 2024**

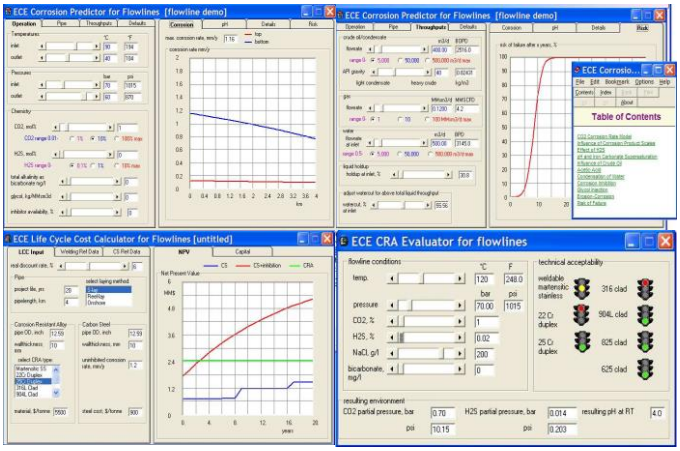
0730 – 0830	***Inhibition in Cooling Water Systems*** *Materials ● Nitrites ● Silicates ● Molybdates ● Phosphates ● Polyphosphates ● Phosphonates ● Multi-component Systems ● Zinc Polyphosphate ● Zinc Phosphonates ● Non-heavy Metal Systems ● Polymer-based Scale Inhibitors ● Passive Films Formed Under Cooling Water Conditions ● Methods for On-line Monitoring/Control of Corrosion ● Inhibitors in Cooling Water Systems*
0830 - 0930	***Inhibitors for Acid Systems*** *Hydrochloric Acid Medium ● Sulfuric Acid Medium ● Nitric AcidHydroflouric Acid ● Phosphoric Acid ● Scale Removal by Acids ● Sulfuric Acid ● Sulfamic Acid ● Citric Acid ● Acetic Acid ● Acidizing Oil Wells*
0930 – 0945	*Break*
0945 – 1030	***Inhibitive Protection of Metals by Organic Coatings*** *Inhibitors ● Chromate Based Pigments ● Chromate Primers ● Evaluation of Painted Samples ● Other Additives in Coatings ● Environment-friendly Coatings for Steel Based on Tannins ● Role of Tannins in Paints ● Mechanism & Protection by Tannins*
1030 – 1130	***Corrosion Inhibition of Copper*** *Corrosion of Copper ● Nature of Oxide Film ● Electrochemical Behavior of the Copper Benzotriazole System ● Photoelectrochemical Behavior ● Surface Analysis of Inhibitor Films ● Stoichiometry & Orientation of Copper Benzotriazole Complex ● Nature of Bonding in Cu(I)BTA Complex*
1130 - 1230	***Economic Considerations*** *Discounted Cash Flow (DCF) ● Verink's Equation ● Example of DCF Calculations*
1230 – 1245	*Break*
1245 – 1300	***Environmentally-Friendly Inhibitors*** *Environmental Guidelines ● Standardized Environmental Testing ● Summary of PARCOM Test Guidelines ● Toxicity ● Biodegradation ● Bioaccumulation*
1300 - 1345	***Selection of Corrosion Inhibitor for Oil & Gas Industry*** *Introduction • Corrosion Inhibition Management • Identify Application Window • Process Data (P,V,T, Flow, etc.) • Compositions (Gas, Oil, Water, Solids) • Equipment (Line, Material (Welds), etc.) • Chemicals • Operations • Identify Operating Range • Process Assessment • Corrosion Analysis • Define Integrity Operating Window (IOW) • Define Corrosion Inhibition (CI) Test Program • Selection of the Corrosion Inhibitor (CI) • Assure CI Performance (Lab/Field) • Adjust Dose Rate, Chemicals & IOW • Report Result*
1345 – 1400	***Course Conclusion*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Course Topics that were Covered During the Course*
1400 – 1415	***POST-TEST***
1415 – 1430	*Presentation of Course Certificates*
1430	*Lunch & End of Course*

Simulator (Hands-on Practical Sessions)

Practical sessions will be organized during the course for delegates to practice the theory learnt. Delegates will be provided with an opportunity to carryout various exercises using the simulators “Corrosion Data Management Software (CDMS)” and “Electronic Corrosion Engineer (ECE®) 5”.



Corrosion Data Management Software (CDMS)



Electronic Corrosion Engineer (ECE®) 5

Course Coordinator

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