COURSE OVERVIEW FE0127
Refractories from the Chemical Point of View

Course Title
Refractories from the Chemical Point of View

Course Date/Venue
Session 1: June 29 – July 03, 2025/Glasshouse Meeting Room, Grand Millennium Al Wahda Hotel, Abu Dhabi, UAE
Session 2: September 21-25, 2025/Glasshouse Meeting Room, Grand Millennium Al Wahda Hotel, Abu Dhabi, UAE

Course Reference
FE0127

Course Duration/Credits
Five days/3.0 CEUs/30 PDHs

Course Description

This practical and highly-interactive course includes real-life case studies and exercises where participants will be engaged in a series of interactive small groups and class workshops.

This course is designed to provide participants with a detailed and up-to-date overview of Refractories from the Chemical Point of View. It covers the refractory materials and the role of refractories in high-temperature industries, historical development of refractory technology and the importance of chemical composition in selection; the refractories based on chemical nature, based on physical form, based on production method and based on usage temperature and application; the key refractory raw materials, basic refractory chemistry, thermodynamics and phase stability and corrosion and erosion mechanisms; and the alumino-silicate refractories, magnesia-based refractories, chromite and spinel refractories, zirconia and high-purity refractories, carbon-containing refractories and bonding mechanisms in refractories.

During this interactive course, participants will learn the chemical attack from slags and fluxes, alkali and sulfur attack in cement and power plants, oxidation and gas phase reactions and hydration and thermal decomposition; the thermal shock and chemical spalling, interaction with molten metals and glass, chemical composition testing and phase identification and microstructure; the refractoriness and softening tests, slag and corrosion testing, thermal and thermochemical tests and chemical durability and lifetime prediction and the refractories in cement and lime industry, refractories in steel and foundry applications, refractories in glass and ceramics, refractories in petrochemical and incineration and refractory failure analysis.

Course Objectives

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

- Apply and gain an in-depth knowledge on refractories from the chemical point of view
- Discuss refractory materials and identify the role of refractories in high-temperature industries, historical development of refractory technology and the importance of chemical composition in selection
- Classify the refractories based on chemical nature, based on physical form, based on production method and based on usage temperature and application
- Identify the key refractory raw materials, basic refractory chemistry, thermodynamics and phase stability and corrosion and erosion mechanisms
- Explain alumino-silicate refractories, magnesia-based refractories, chromite and spinel refractories, zirconia and high-purity refractories, carbon-containing refractories and bonding mechanisms in refractories
- Recognize chemical attack from slags and fluxes, alkali and sulfur attack in cement and power plants, oxidation and gas phase reactions and hydration and thermal decomposition
- Carryout thermal shock and chemical spalling, interaction with molten metals and glass, chemical composition testing and phase identification and microstructure
- Demonstrate refractoriness and softening tests, slag and corrosion testing, thermal and thermochemical tests and chemical durability and lifetime prediction
- Discuss refractories in cement and lime industry, refractories in steel and foundry applications, refractories in glass and ceramics, refractories in petrochemical and incineration and refractory failure analysis

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 conveniently saved in a **Tablet PC**.*

Who Should Attend

This course provides an overview of all significant aspects and considerations of refractories from the chemical point of view for chemical engineers, materials scientists and engineers, metallurgists, corrosion engineers, quality assurance and qc engineers and other technical staff.

Accommodation

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

Course Fee

US$ 5,500 per Delegate + **VAT**. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

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: -

- 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.

- 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 **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.

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:

Mr. Michael Linck, MBA, BBA, is a **Senior Piping & Mechanical Engineer** with over **30 years** of practical experience in the **Oil**, **Gas**, **Petrochemical** and **Power** industries. His expertise covers **Refractory Inspection**, **ASME Post Construction Code**, **Inspection Planning**, **Fitness-for-Service**, **Damage Mechanisms & Repair of Vessels**, **Tanks**, **Piping & Process Equipment**, **Pipeline Pigging**, **Pipeline Integrity Assessment**, **Corrosion Monitoring**, **Control**, **Prevention** and **Inspection**, **Screw Compressors**, **Building & Facilities Maintenance Management**, **Maintenance Planning**, **Maintenance Auditing & Benchmarking**, **Risk Management Program** (**RMP**), **Reliability**, **Availability & Maintability** (**RAM**), **Material Cataloguing**, **planning** and **implementation** of small to large **boiler projects**, **insulation**, **scaffolding**, installation, operation and inspection of steel, cement, petrochemical and power industries, both new installations and aftermarket service projects. Currently, he is the **VP of Operations** for **Refractory Repair Services** as well as the **President** of **LINCK REFRACTORY INTERNATIONAL SERVICES**, taking full charge of all refractory and mechanical maintenance related operations.

Earlier in his career life, Mr. Linck held numerous significant and challenging positions as the **Commissioning Specialist**, **Maintenance Specialist**, **Contract Specialist**, **Site Manager**, **General Manager**, **Project Manager**, **Branch Manager**, **Construction Manager**, **Manager** and **Contract Site Service Representative** in several international companies such as **Foster Wheeler**, **NV Gouda Vuurvast**, **Insultec Ltd**., **National Refractories Clay Alumina Specialties**, **Thermo Tech**, **Turnaround Maintenance Inc**., **Solar Industries** and **Anco Industries**.

Mr. Linck has a **Master's** and **Bachelor's** degree in **Engineering** from the **North Texas University** and **University of Dallas** respectively. He is **certified** as an **API 936 Refractory Personnel, a Certified API 982 Refractory Inspector** early in 2003 as well as holds or has held state contracting licenses related to heavy construction and engineering in West Virginia, Mississippi, Louisiana, Oklahoma and Arizona

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 Program

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

Day 1

0730 – 0800	*Registration & Coffee*
0800 – 0815	*Welcome & Introduction*
0815 – 0830	***PRE-TEST***
0830 – 0930	***Introduction to Refractory Materials*** *Definition and Role of Refractories in High-Temperature Industries • Basic Requirements: Chemical Inertness, Thermal Stability, Mechanical Integrity • Historical Development of Refractory Technology • Importance of Chemical Composition in Selection*
0930 – 0945	*Break*
0945 – 1030	***Classification of Refractories*** *Based on Chemical Nature: Acidic, Basic, Neutral • Based on Physical Form: Shaped versus Monolithic • Based on Production Method: Fused, Sintered, Castables • Based on Usage Temperature and Application*
1030 – 1130	***Key Refractory Raw Materials*** *Alumina, Silica, Magnesia, Chromite, Zirconia • Source, Purity and Reactivity • Role of Impurities and Secondary Oxides • Natural versus Synthetic Raw Materials*
1130 – 1215	***Basic Refractory Chemistry*** *Oxide Bonding and Crystal Structures • Phase Diagrams of Binary Oxide Systems • Solid-State Reactions During Firing • Thermochemical Stability of Phases*
1215 – 1230	*Break*
1230 – 1330	***Thermodynamics & Phase Stability*** *Gibbs Free Energy and Equilibrium Reactions • Stability of Refractory Oxides at High Temperatures • Reaction with Gases and Slags • Phase Transformation Temperatures*
1330 – 1420	***Corrosion & Erosion Mechanisms*** *Chemical Attack by Slags, Alkalis, and Acids • Oxidation and Reduction Effects • Reaction Kinetics and Diffusion Mechanisms • Wear Modes: Corrosion, Abrasion, Spalling*
1420 – 1430	***Recap*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow*
1430	*Lunch & End of Day One*

Day 2

0730 – 0830	***Alumino-Silicate Refractories*** *Kaolinite and Mullite Formation • SiO_2–Al_2O_3 Phase Diagram • Glassy Phase Content and Implications • Refractoriness and Thermal Shock Behavior*
0830 – 0930	***Magnesia-Based Refractories*** *MgO Purity and Reactivity • Periclase Formation and Grain Size Control • Magnesia-Carbon and MgO–Cr_2O_3 Systems • Resistance to Basic Slags and CO Gas*

0930 – 0945	Break
0945 – 1100	***Chromite & Spinel Refractories*** Chromite Chemistry and Cr_2O_3 Phases • Formation of Spinels ($MgAl_2O_4$, $MgCr_2O_4$) • Stability in Oxidizing versus Reducing Environments • Environmental Concerns (Hexavalent Chromium)
1100 – 1215	***Zirconia & High-Purity Refractories*** ZrO_2 Polymorphism and Stabilizers (CaO, MgO, Y_2O_3) • Thermal Expansion Behavior • Application in Aggressive Environments • Phase Stability at High Temperatures
1215 – 1230	Break
1230 – 1420	***Carbon-Containing Refractories*** Graphite and Carbon Bonding • Impregnation with Pitch and Resins • Oxidation Resistance Strategies • Chemical Degradation and Protection Coatings
1330 – 1420	***Bonding Mechanisms in Refractories*** Ceramic Bonding via Sintering • Chemical Bonding in Phosphate-Bonded Systems • Hydraulic Bonding in Castable • Resin and Pitch Bonding in Carbon Refractories
1420 – 1430	***Recap*** Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow
1430	Lunch & End of Day Two

Day 3

0730 – 0830	***Chemical Attack from Slags & Fluxes*** Types of Industrial Slags (Acidic, Basic, Neutral) • Thermochemical Interaction and Dissolution • Slag Infiltration and Corrosion Modeling • Chemical Compatibility Testing
0830 – 0930	***Alkali & Sulfur Attack in Cement & Power Plants*** Reactions with K_2O, Na_2O, SO_2/SO_3 • Alkali Silica and Potassium-Alumina Reactions • Sulfate Expansion and Structural Damage • Protective Coating and Material Selection
0930 – 0945	Break
0945 – 1100	***Oxidation & Gas Phase Reactions*** CO/CO_2 and O_2 Reaction with Carbon Refractories • Chlorine, Fluorine, and Halogen Attack • Volatile Species Condensation • Role of Oxygen Potential and Partial Pressures
1100 – 1215	***Hydration & Thermal Decomposition*** Hydration of CaO- and MgO-Containing Materials • Steam and Water Vapor Effects • Decomposition of Carbonates and Hydrates • Formation of Low-Melting Eutectics
1215 – 1230	Break
1230 – 1330	***Thermal Shock & Chemical Spalling*** Role of Expansion Mismatch and Chemical Inhomogeneity • Crack Propagation Due to Chemical Alteration • Repeated Attack from Temperature Cycling • Strategies for Minimizing Thermal Shock

1330 – 1420	***Interaction with Molten Metals & Glass*** *Refractory Wetting and Contact Angle Chemistry • Reactions with Metal Oxides and Slags • Chemical Wear in Glass Tanks and Ladles • Redox Reactions at Refractory-Metal Interface*
1420 – 1430	***Recap*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow*
1430	*Lunch & End of Day Three*

Day 4

0730 – 0830	***Chemical Composition Testing*** *X-ray Fluorescence (XRF) and Wet Chemical Analysis • Loss on Ignition (LOI) and Volatile Matter • Determining Major and Trace Elements • Impact of Chemical Variability on Performance*
0830 – 0930	***Phase Identification & Microstructure*** *X-ray Diffraction (XRD) for Phase Analysis • SEM/EDS for Morphology and Elemental Mapping • Optical Microscopy and Porosity Distribution • Evaluation of Reaction Zones and Wear Layers*
0930 – 0945	*Break*
0945 – 1100	***Refractoriness & Softening Tests*** *Pyrometric Cone Equivalent (PCE) • Refractoriness Under Load (RUL) • Hot Modulus of Rupture (HMOR) • Influence of Chemistry on High-Temp Strength*
1100 – 1215	***Slag & Corrosion Testing*** *Static Cup and Rotary Slag Tests • Slag Penetration Depth Measurement • Chemical Compatibility Rating • Alkali Resistance and Sulfur Test Methods*
1215 – 1230	*Break*
1230 – 1330	***Thermal & Thermochemical Tests*** *Thermal Conductivity and Expansion • Thermal Shock Resistance by Quenching • Thermogravimetric Analysis (TGA) • DTA and DSC for Phase Changes*
1330 – 1420	***Chemical Durability & Lifetime Prediction*** *Simulation of Operating Environments • Chemical Aging and Degradation Models • Residual life Estimation Using Lab Results • Predictive Maintenance Planning*
1420 – 1430	***Recap*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow*
1430	*Lunch & End of Day Four*

Day 5

0730 – 0830	***Refractories in Cement & Lime Industry*** *Resistance to Alkali, Sulfur, and Coating Formation • Selection for Kiln, Cooler, Preheater Zones • Interaction with Clinker Chemistry • Corrosion and Chemical Wear Mechanisms*
0830 – 0930	***Refractories in Steel & Foundry Applications*** *Interaction with Basic and Acidic Slags • Chemistry of Tundish and Ladle Linings • Carbon and MgO-C Applications • Hot Metal Desulfurization Effects*

0930 – 0945	*Break*
0945 – 1100	***Refractories in Glass &Ceramics*** *Silica-Based Refractories and Na_2O Vapor Attack • Phase stability in Glass-Contact Environments • Chemistry of Glass Corrosion •Defect Generation and Refractory Contribution*
1100 – 1215	***Refractories in Petrochemical & Incineration*** *Acidic gas Resistance and Chemical Spalling • Chloride/Sulfate Attack in Secondary Reformers • Low-Porosity and Chemically Inert Materials • Special Binders for Corrosion Resistance*
1215 – 1230	*Break*
1230 – 1300	***Refractory Failure Analysis*** *Chemical Mapping of Degraded Sections • Hot Spot and Slag Line Failure Chemistry • Alkali Attack Zone Identification • Strategies for Prevention and Material Redesign*
1300 - 1345	***Future Trends in Refractory Chemistry*** *Nano-Engineered Binders and Additives • Chemically Bonded No-Cement Castables • Self-healing and Intelligent Refractory Materials • Circular Economy: Recycling and Low-Carbon Refractories*
1345 – 1400	***Course Conclusion*** *Using this Course Overview, the Instructor(s) will Brief Participants about t Topics that were Covered During the Course*
1400 – 1415	***POST-TEST***
1415 – 1430	*Presentation of Course Certificates*
1430	*Lunch & End of Course*

Practical Sessions

This practical and highly-interactive course includes real-life case studies and exercises:-

Course Coordinator

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