مركز المستشار الوطني للتدريب
National Consultant Centre For Training
YOUR GATE TO HANDS-ON TRAINING

5-Day Cement Industry Training Course
In

REFRACTORIES FROM THE CHEMICAL POINT OF VIEW

Dubai - UAE, 06 – 10 Apr. 2026

COURSE LEVEL: ADVANCED

COURSE OVERVIEW:

Refractories in the cement industry are not merely mechanical barriers but are dynamic chemical participants that must withstand extreme heat, corrosive gases, and abrasive materials. This course defines the chemical interactions between the kiln atmosphere, the clinker coating, and the internal lining of the pyro-processing system. It establishes a profound understanding of how mineralogical compatibility dictates the longevity and reliability of the kiln refractory.

The scope of this training involves the study of the chemical composition of basic (Magnesite-Spinel) and non-basic (Alumina-Silica) refractories. It covers the mechanisms of "Chemical Attack," including alkali infiltration, carbon monoxide disintegration, and sulfate penetration, which lead to premature failure. Furthermore, the course addresses the "Coating Formation" process, explaining how chemical equilibrium between clinker and brick creates a protective sacrificial layer.

Coverage includes detailed modules on thermal expansion chemistry, the impact of alternative fuels on refractory mineralogy, and the selection of castables for high-volatile environments. Participants will explore the role of "Redox Conditions" in the kiln and how they influence the oxidation state of the lining components. Through the study of phase diagrams and post-mortem failure analysis, attendees will gain the expertise to select and maintain refractories based on the specific chemical challenges of their plant.

COURSE OBJECTIVES:

After completion of this course, the participants will be able to:

- Identify the chemical classification of refractories (Acidic, Basic, Neutral).
- Understand the mineralogical components of Magnesite, Spinel, and Chrome bricks.
- Explain the chemical mechanism of "Alkali Infiltration" and brick bursting.
- Analyze the role of "Coating" as a chemical shield for the refractory.
- Evaluate the impact of "Alternative Fuels" on lining chemistry.
- Describe the "Carbon Monoxide Disintegration" of Alumina bricks.
- Understand the chemical reactions leading to "Sulfatization" of refractories.
- Select refractory materials based on the "Sulfur/Alkali" environment.
- Explain the "Thermal Shock" resistance from a molecular perspective.
- Analyze the impact of "Reducing Atmospheres" on refractory iron content.
- Conduct "Post-Mortem" chemical analysis on failed refractory samples.

- Optimize the "Heating-up Curve" to ensure chemical bond stability.

TARGET AUDIENCE:

This course is intended for Refractory Engineers, Maintenance Managers, Process Engineers, and Plant Chemists.

TRAINING COURSE METHODOLOGY:

A highly interactive combination of lectures, discussion sessions, and case studies will be employed to maximize the transfer of information, knowledge, and experience. The course will be intensive, practical, and highly interactive. The sessions will start by raising the most relevant questions and motivating everybody to find the right answers. The attendants will also be encouraged to raise more of their questions and to share in developing the right answers using their analysis and experience. There will also be some indoor experiential activities to enhance the learning experience. Course material will be provided in PowerPoint, with necessary animations, learning videos, and general discussions.

The course participants shall be evaluated before, during, and at the end of the course.

COURSE CERTIFICATE:

National Consultant Centre for Training LLC (NCC) will issue an Attendance Certificate to all participants completing a minimum of 80% of the total attendance time requirement.

COURSE OUTLINE / COURSE CONTENT:

MODULE 1: CHEMICAL CLASSIFICATION OF REFRACTORIES

- Basic refractories: Magnesite, Mag-Chrome, and Mag-Spinel.
- Acidic and Neutral refractories: Silica, Fireclay, and High Alumina.
- Understanding the "Amphoteric" nature of Alumina.
- Chemical bonding types: Ceramic, Chemical, and Hydraulic.
- Overview of refractory raw minerals (Periclase, Corundum, Andalusite).

MODULE 2: REFRACTORY PHASE DIAGRAMS

- Introduction to the Al_2O_3-SiO_2 phase diagram.
- Understanding the CaO-Al_2O_3-SiO_2 system in the kiln.
- Predicting "Liquid Phase" formation within the brick.
- Impact of minor oxides (TiO_2, K_2O) on melting points.
- Using phase diagrams to select materials for the burning zone.

MODULE 3: MECHANISMS OF ALKALI AND CHLORIDE ATTACK

- Diffusion of volatile salts into the refractory pores.
- The "Salt Cycle" and its chemical impact on the lining.
- Formation of expansive minerals: Sodalite and Noselite.
- Mechanism of "Structural Spalling" due to densification.
- Selection of "Alkali-Resistant" castables and bricks.

MODULE 4: SULFATE AND REDOX CHEMISTRY

- Interaction between sulfur gases and basic bricks.
- The formation of Calcium Sulfate and its volume increase.
- Impact of "Reducing Conditions" on Iron Oxide (Fe_2O_3) in bricks.
- Chemical instability of Chrome-containing refractories.
- Managing the "Sulfur/Alkali Ratio" for refractory longevity.

MODULE 5: CHEMISTRY OF COATING FORMATION

- The chemical bond between "Liquid Clinker" and "Basic Refractory."
- Role of the "Reaction Layer" in brick protection.
- Factors affecting coating stability: Temperature vs. Chemistry.
- Chemical causes of "Coating Fall" and its impact on the lining.
- Engineering a raw mix for "Refractory-Friendly" coating.

MODULE 6: REFRACTORIES FOR ALTERNATIVE FUELS (AF)

- Impact of "High Chlorine" waste fuels on refractory chemistry.
- Chemical erosion from "Vitreous" alternative fuel ash.
- Selecting "Silicon Carbide" (SiC) for its anti-sticking properties.
- Chemical stability of "Zirconia-containing" refractories.
- Monitoring the "Internal Shell Corrosion" caused by AF acids.

MODULE 7: CASTABLES AND MONOLITHICS CHEMISTRY

- Chemistry of "Calcium Aluminate Cements" (CAC).
- Low-Cement Castables (LCC) and Ultra-Low Cement (ULCC) chemistry.
- The role of "Deflocculants" and "Micro-silica" in performance.
- Chemical dehydration during the "First Heat-up."
- Understanding "Hydraulic" vs. "Phosphate" bonding.

MODULE 8: POST-MORTEM CHEMICAL ANALYSIS

- Techniques for sampling failed refractory linings.
- Using XRF and XRD to identify chemical contaminants.
- Microscopic analysis of "Slag Penetration" depth.
- Identifying "Chemical Coring" and "Thermal Alteration" zones.
- Correlating chemical findings with kiln operational data.

MODULE 9: THERMAL CONDUCTIVITY AND HEAT FLOW

- Relationship between mineral density and heat transfer.
- Chemical impact of "Insulating Layers" and "Back-up" linings.
- Managing the "Shell Temperature" through chemical selection.
- Thermal expansion mismatch: Chemical and mechanical implications.
- Energy efficiency vs. Chemical durability trade-offs.

MODULE 10: QUALITY ASSURANCE AND SELECTION STRATEGY

- Technical specifications for refractory procurement.

- Verifying the "Chemical Analysis" of delivered bricks.
- Impact of "Porosity" and "Permeability" on chemical resistance.
- Designing a "Zonal Refractory Plan" based on gas chemistry.
- Course summary and final assessment on refractory chemistry.