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

5-Day Cement Industry Training Course
In

RAW MIX DESIGN

Dubai - UAE, 23 – 27 Mar. 2026

COURSE LEVEL: ADVANCED

COURSE OVERVIEW:

Raw mix design is the scientific process of calculating the precise proportions of limestone, clay, and corrective materials needed to produce high quality clinker. This course defines the mathematical and chemical constraints that govern the raw meal composition, ensuring optimal kiln performance and product durability. It establishes a rigorous approach to balancing chemical targets with the physical realities of the quarry and available industrial wastes.

The scope of this training involves the mastery of the three fundamental moduli: Lime Saturation Factor (LSF), Silica Ratio (SR), and Alumina Ratio (AR). It covers the influence of minor components—such as alkalis, chlorides, and sulfates—on the burnability of the mix and the eventual mineralogy of the clinker. Furthermore, the course addresses the use of specialized software and linear programming techniques to solve complex multi-component blending problems under economic constraints.

Coverage includes detailed modules on the impact of ash absorption from fuels, the management of raw material variability, and the optimization of the liquid phase for clinker nodulization. Participants will explore the relationship between the raw mix design and the heat consumption of the kiln, learning how to engineer a mix that is both reactive and energy efficient. Through the study of chemical stoichiometry and mineralogical calculations, attendees will gain the expertise to maintain stable kiln operations and superior cement quality.

COURSE OBJECTIVES:

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

- Calculate the Lime Saturation Factor (LSF), Silica Ratio (SR), and Alumina Ratio (AR).
- Define the chemical targets for different clinker types (OPC, SRC, Low Heat).
- Adjust the raw mix to account for fuel ash absorption in the kiln.
- Analyze the burnability of a raw mix using the Lea and Parker formula.
- Optimize the "Liquid Phase" percentage for improved sintering zone performance.
- Manage the impact of MgO and Free Lime on cement soundness.
- Incorporate alternative raw materials and industrial by-products into the mix.
- Predict clinker mineralogy using Bogue equations based on the raw mix.
- Minimize the specific heat consumption by optimizing mix reactivity.
- Control the volatile cycles of alkalis and sulfur through mix chemistry.
- Utilize advanced blending software for multi-component mix optimization.

- Evaluate the cost-effectiveness of different corrective material options.

TARGET AUDIENCE:

This course is intended for Process Engineers, Quality Control Managers, Plant Chemists, and Production Managers.

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: FUNDAMENTALS OF CEMENT CHEMISTRY

- The four major oxides: CaO, SiO2, Al2O3, and Fe2O3.
- Role of the clinker phases: Alite, Belite, Aluminate, and Ferrite.
- Introduction to cement chemistry notation (C, S, A, F).
- Relationship between raw meal chemistry and clinker minerals.
- Safety and environmental regulations in chemical handling.

MODULE 2: THE MODULI AND RATIOS IN MIX DESIGN

- Detailed calculation of the Lime Saturation Factor (LSF).
- Understanding and controlling the Silica Ratio (SR).
- The impact of the Alumina Ratio (AR) on the liquid phase.
- Balancing the moduli for kiln stability vs. cement strength.
- Impact of "Over-liming" and "Under-liming" the kiln feed.

MODULE 3: THE SINTERING PROCESS AND LIQUID PHASE

- Calculating the percentage of liquid phase at 1450°C.
- Influence of the Alumina Ratio on liquid viscosity and surface tension.
- Role of fluxing agents in reducing the clinkering temperature.
- Impact of the liquid phase on clinker nodulization and size.
- Relationship between liquid phase and refractory lining life.

MODULE 4: BURNABILITY AND REACTIVITY OF THE MIX

- Factors affecting mix burnability: Chemistry vs. Fineness.
- Using the "Burnability Index" to predict kiln performance.
- Impact of quartz and coarse calcite on the burning process.
- Calculating the "Lea and Parker" burnability factor.
- Laboratory methods for testing raw mix reactivity.

MODULE 5: FUEL ASH ABSORPTION AND CALCULATIONS

- Chemical composition of coal, petcoke, and alternative fuel ash.
- Calculating the ash absorption rate based on specific heat consumption.
- Adjusting the raw mix LSF to compensate for fuel sulfur and ash.
- Impact of "Reducing Conditions" on clinker mineral formation.
- Managing the "Sulfur/Alkali" balance in the kiln system.

MODULE 6: CORRECTIVE MATERIALS AND ADDITIVES

- Use of high-grade limestone, iron ore, and silica sand.
- Incorporating bauxite and other alumina sources.
- Benefits and risks of using industrial wastes (slag, fly ash, scales).
- Calculating the dosing rates for four and five-component mixes.
- Impact of minor elements (Ti, Mn, Cr) on clinker color and quality.

MODULE 7: VOLATILES AND MINOR COMPONENTS

- Managing the cycles of Alkalis (K2O, Na2O), Chlorine, and Sulfur.
- Impact of volatiles on "Preheater Blockages" and "Ring Formation."
- Calculating the "Equivalent Alkali" (Na_2O_{eq}) for cement.
- Strategies for raw mix adjustments in high-volatile environments.
- The role of the "Chlorine Bypass" system in mix design.

MODULE 8: MATHEMATICAL MODELS FOR MIX OPTIMIZATION

- Using the "Pearson Square" for two-component blending.
- Introduction to "Simultaneous Linear Equations" for complex mixes.
- Role of "Matrix Algebra" in modern mix design software.
- Establishing "Cost Functions" to minimize the raw material budget.
- Sensitivity analysis: Predicting the impact of quarry fluctuations.

MODULE 9: QUARRY MANAGEMENT AND HOMOGENIZATION

- Linking the raw mix design to the "Quarry Block Model."
- Impact of pre-blending yard efficiency on raw mix stability.
- Role of "On-line Analyzers" (PGNAA) in real-time mix control.
- Managing the "Standard Deviation" of the raw meal LSF.
- Strategies for handling "High MgO" or "High Sulfur" limestone pockets.

MODULE 10: QUALITY CONTROL AND TROUBLESHOOTING

- Correlating clinker "Free Lime" results with raw mix LSF.

- Troubleshooting "Kiln Rings" through chemical adjustments.
- Impact of raw mix fineness on the chemical reaction rate.
- Final clinker mineralogy verification using Bogue and XRD.
- Course wrap-up: Developing a master raw mix design sheet.