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

5-Day Cement Industry Training Course
In

SULPHATE RING FORMATION

Dubai - UAE, 06 – 10 July 2026

COURSE LEVEL: ADVANCED

COURSE OVERVIEW:

Sulphate ring formation is a critical operational challenge in the cement industry that directly impedes the flow of material and gases within the rotary kiln. This course defines the chemical mechanisms by which volatile sulphur compounds recirculate and condense to form hardened mineral deposits. It establishes a technical framework for identifying the root causes of ring growth and implementing preventative process strategies.

The scope of this training involves the study of the sulphur-to-alkali balance and its role in creating sticky melt phases at the kiln inlet and burning zone. It covers the impact of fuel quality, raw material composition, and oxygen levels on the stability of calcium sulphate phases. Furthermore, the course addresses the mechanical and thermal consequences of ring formation, including increased pressure drops, reduced throughput, and potential damage to the kiln refractory.

Coverage includes detailed modules on the use of bypass systems to mitigate volatile buildup and the adjustment of burner parameters to alter the kiln's thermal profile. Participants will explore diagnostic techniques such as gas analysis, shell temperature monitoring, and visual inspections during shutdowns. Through the study of chemical stoichiometry and process thermodynamics, attendees will gain the expertise to manage sulphur cycles and maintain continuous, stable kiln operation.

COURSE OBJECTIVES:

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

- Explain the chemical cycle of sulphur within the preheater and kiln system.
- Identify the different types of kiln rings and their specific locations.
- Calculate the sulphur-to-alkali ratio to predict ring formation risk.
- Analyze the impact of "Reducing Conditions" on sulphur volatility.
- Understand the role of "Spurrite" and "Anhydrite" in ring mineralogy.
- Optimize the oxygen levels in the kiln back-end to suppress ring growth.
- Evaluate the effect of fuel sulphur content on process stability.
- Use kiln shell scanners to detect early signs of ring formation.
- Implement effective "Thermal Shocking" techniques to remove existing rings.
- Manage the operation of a "Chlorine/Sulphur Bypass" system.
- Adjust the raw mix design to compensate for high sulphur inputs.
- Develop a proactive monitoring plan to prevent emergency kiln shutdowns.

TARGET AUDIENCE:

This course is intended for Kiln Operators, Process Engineers, Production Managers, 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: CHEMISTRY OF VOLATILE CYCLES

- Understanding the evaporation and condensation of sulphur compounds.
- Role of alkalis (K2O and Na2O) in neutralizing sulphur.
- Chemical reactions between SO2, O2, and CaO in the kiln.
- Impact of chlorides on the melting point of sulphate deposits.
- Volatility factors of various sulphur species in the burning zone.

MODULE 2: KILN RING CLASSIFICATION

- Sintering zone rings (Clinker rings) vs. Sulphate rings.
- Identifying "Mid-kiln" rings and "Inlet" build-ups.
- Physical characteristics: Hardness, porosity, and color of rings.
- Mechanism of "Meal Rings" in the preheater riser duct.
- Impact of rings on kiln gas velocity and material residence time.

MODULE 3: THE SULPHUR-TO-ALKALI BALANCE

- Calculating the molar ratio of sulphur to total alkalis.
- Impact of an "Excess Sulphur" environment on melt formation.
- Determining the "Degree of Sulphatization" in the kiln.
- Strategies for adding alkalis or reducing sulphur in the raw mix.
- Predicting ring risk based on daily laboratory clinker analysis.

MODULE 4: INFLUENCE OF COMBUSTION CONDITIONS

- Role of excess air (O2) in stabilizing calcium sulphate.
- Impact of "Reducing Atmosphere" (CO) on sulphur release.
- Burner flame shaping to prevent localized overheating of the shell.
- Managing the "Sulfur Burst" effect during fuel transitions.
- Relationship between secondary air temperature and ring growth.

MODULE 5: DIAGNOSTIC TOOLS AND MONITORING

- Interpreting "Kiln Inlet Pressure" trends as ring indicators.
- Using infrared shell scanners to identify cold spots (rings).
- Visual inspection techniques through kiln observation ports.
- Role of the "Kiln Drive Amperage" in detecting material obstructions.
- Analyzing "Bypass Dust" chemistry to monitor volatile cycles.

MODULE 6: BYPASS SYSTEMS AND MITIGATION

- Design and operation of the "Sulphur/Chlorine Bypass."
- Impact of bypass quenching air on thermal efficiency.
- Managing the disposal or recycling of "Bypass Dust."
- Calculating the "Bypass Rate" required for process stability.
- Maintenance challenges of bypass probes and cooling chambers.

MODULE 7: OPERATIONAL TECHNIQUES FOR RING REMOVAL

- The "Thermal Shocking" method: Controlled temperature swings.
- Mechanical removal: Using "Industrial Kiln Guns" and projectiles.
- Adjusting the kiln speed to induce "Ring Fall."
- Risks of "Kiln Flushing" following a major ring collapse.
- Safety protocols for manual ring removal during shutdowns.

MODULE 8: RAW MATERIAL AND FUEL MANAGEMENT

- Screening the quarry for "Pyrite" and high-sulphur limestone.
- Managing the sulphur content in petroleum coke and coal.
- Impact of alternative fuels (RDF, Tires) on the sulphur cycle.
- Using "Chemical Additives" to modify the sulphate melt phase.
- Establishing "Acceptance Limits" for high-sulphur additives.

MODULE 9: IMPACT ON REFRACTORY AND EQUIPMENT

- Chemical attack of sulphate melts on basic kiln bricks.
- Accelerated wear of the kiln inlet seal due to build-ups.
- Mechanical stress on the kiln drive during unbalanced ring loads.
- "Snowman" formation in the cooler linked to sulphate chemistry.
- Energy losses associated with restricted gas flow and high fan power.

MODULE 10: CASE STUDIES AND PREVENTATIVE PLANNING

- Root cause analysis of a chronic ring formation incident.
- Developing a "Standard Operating Procedure" (SOP) for ring management.
- Integrating ring detection into the plant DCS alarms.

- Long-term strategies for kiln process optimization.