COURSE OVERVIEW PE1053
Cement Quality & Chemistry

Course Title
Cement Quality & Chemistry

Course Date/Venue
August 24-28, 2025/Tamra Meeting Room, Al Bandar Rotana Creek, Dubai, UAE

Course Reference
PE1050

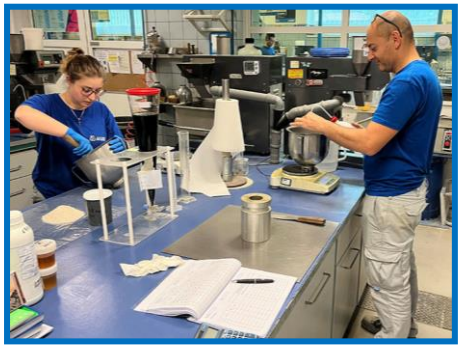
Course Duration/Credits
Five days/3.0 CEUs/30 PDHs

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 Cement Quality and Chemistry. It covers the definitions and role of cement in cement chemistry; the oxide composition and cement chemistry notation; the raw material chemistry, clinker chemistry and phase composition, chemical modules and chemical reactions during clinker formation; the hydration of portland cement, hydration products and their role and influence of clinker composition on hydration; and setting time and early reactions, heat hydration, pozzolanic and supplementary cementitious materials (SCMs).

During this interactive course, participants will learn the chemical analysis techniques, clinker and cement phase analysis and physical properties affecting quality; compressive strength testing, SO_3 optimization and control and alkalis and chloride in cement; the international cement standards, statistical quality control (SQC) process control based on chemistry and the quality assurance in cement laboratory; environmental considerations and chemistry and troubleshoot quality deviations; durability of cement-based materials, the alkali-aggregate reaction (AAR), white and special cements; and the blended cements and performance optimization.



Course Objectives

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

- Apply and gain an in-depth knowledge on cement quality and chemistry
- Discuss the definitions and role of cement in cement chemistry covering the basic construction, types of cement, manufacturing process and the importance of chemical composition in quality control
- Identify the oxide composition and cement chemistry notation including the major oxides, minor/trace oxides and cement chemistry notation
- Explain raw material chemistry, clinker chemistry and phase composition, chemical modules and chemical reactions during clinker formation
- Discuss the hydration of portland cement as well as hydration products and their role and influence of clinker composition on hydration
- Set time and early reactions and apply heat hydration, pozzolanic and supplementary cementitious materials (SCMs)
- Define chemical analysis techniques, clinker and cement phase analysis and physical properties affecting quality
- Carryout compressive strength testing, SO_3 optimization and control and alkalis and chloride in cement
- Discuss the international cement standards, apply statistical quality control (SQC) process control based on chemistry and the quality assurance in cement laboratory
- Employ environmental considerations and chemistry and troubleshoot quality deviations
- Assess durability of cement-based materials including the alkali-aggregate reaction (AAR), white and special cements and blended cements and performance optimization

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 cement quality and chemistry for process engineers, quality control engineers, laboratory technicians, chemists, cement plant operators, production supervisors, R&D personnel, technical services engineers, maintenance engineers (related to kiln and mill operations), environmental engineers, HSE officers (involved with material handling), raw material analysts, clinker production personnel, procurement specialists (for raw materials and additives), new graduate engineers (in training) and other technical staff.

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 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.

Accommodation

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

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. Manuel Dalas, PEng, MSc, BSc, is a **Senior Process Engineer** with almost **30 years** of industrial experience within the **Oil & Gas**, **Refinery**, **Petrochemical** and **Refinery** industries. His expertise widely includes in the areas of **Process Engineering & Systems Failure** Analysis, **Equipment & Mechanical Integrity**, **Process Failure** Prevention, **Engineering Modifications & Systems Failures**, **Cement Manufacturing**, **Cement** Grinding Flow Sheet, **Cement** Quality & Chemistry, **Cement Kiln** Process &Operation, Root Cause Failure Analysis (**RCFA**) Techniques, **Methodology Selection** based on Specific Scenarios, **Process Plant** Optimization, **Revamping & Debottlenecking**, **Process Plant** Troubleshooting & Engineering Problem Solving, **Process Plant** Operations, **Mass & Material Balance**, **Oil & Gas Processing**, **Process Plant** Performance & Efficiency, **Crude Distillation** Process Saturated Gas Process Technology, **Crude Dehydration & Desalting**, **Crude** Stabilization Operations, **Heat Exchangers & Fired Heaters** Operation & Troubleshooting, **Pressure Vessels** Maintenance & Operation, **Piping Support**, **Ironworks**, **Rotating & Static Equipment** (**Pumps**, **Valves**, **Boilers**, **Pressure Vessels**, **Tanks**, **Bearings**, **Compressors**, **Pipelines**, **Motors**, **Turbines**, **Gears**, **Seals**), **Hydrogen Sulphide Stripping**, **Crude Oil De Salting** Process, **Gas Conditioning**, **NGL Recovery & NGL Fractionation**, **Flare** Systems, Pre-Fabrication of **Steel Structure**, Alloy Piping Pre-Fabrication, **Vertical Columns/Pressure Vessels**, **Distillation Column**, **Steel Structures**, **Construction** Management, **Building** Structures and **Electrical-Mechanical Equipment**. Currently, he is the **Technical Consultant** of the **Association of Local Authorities** of **Greater Thessaloniki** wherein he oversees mechanical engineering services while focusing on system reviews and improvements. His role involves a strategic approach to enhancing operational efficiencies and implementing robust solutions in complex engineering environments.

During his career life, Mr. Dalas has gained his practical and field experience through his various significant positions and dedication as the **Technical Manager**, **Construction Manager**, **Senior Process Engineer**, **Process Safety Engineer**, **Process Design Engineer**, **Project Engineer**, **Production Engineer**, **Construction Engineer**, **Consultant Engineer**, **Technical Consultant**, **Safety Engineer**, **Mechanical Engineer**, **External Collaborator**, **Deputy Officer** and **Senior Instructor/Trainer** for various companies including the Alpha Astika, Anamorfosis Technical Firm, EKME, ASTE, Elof Consulting and Hypergroup.

Mr. Dalas is a **Registered Professional Engineer** and has a **Master's** degree in **Energy System** from the **International Hellenic University** and a **Bachelor's** degree in **Mechanical Engineering** from the **Mechanical Engineering Technical University**, **Greece** along with a **Diploma** in **Management & Production Engineering** from the **Technical University** of **Crete**. Further, he is a **Certified Internal Verifier/Assessor/Trainer** by the **Institute of Leadership and Management** (**ILM**), a **Certified Project Manager Professional** (**PMI-PMP**), a **Certified Instructor/Trainer**, a **Certified Energy Auditor** for **Buildings**, **Heating & Climate Systems**, a **Member** of the **Hellenic Valuation Institute** and the **Association of Greek Valuers** and a **Licensed Expert Valuer Consultant** of the **Ministry of Development and Competitiveness**. He has further delivered numerous trainings, courses, seminars, conferences and workshops internationally.

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: ***Sunday, 24th of August 2025***

0730 – 0800	*Registration & Coffee*
0800 – 0815	*Welcome & Introduction*
0815 – 0830	***PRE-TEST***
0830 – 0930	***Introduction to Cement Chemistry*** *Basic Definitions & Role of Cement in Construction • Types of Portland Cement & Blended Cement • Overview of Cement Manufacturing Process • Importance of Chemical Composition in Quality Control*
0930 – 0945	*Break*
0945 – 1030	***Oxide Composition & Cement Chemistry Notation*** *Major Oxides: CaO, SiO_2, Al_2O_3, Fe_2O_3 • Minor/Trace Oxides: MgO, SO_3, K_2O, Na_2O, TiO_2 • Cement Chemistry Notation (C, S, A, F, H, Etc.) • Molecular & Weight-Based Representation*
1030 – 1130	***Raw Material Chemistry & its Impact*** *Raw Material Sources & Chemical Variability • Effect of Impurities on Clinker Formation • Role of Correctives & Minor Additives • Influence on Burnability & Clinker Phase Development*
1130 – 1215	***Clinker Chemistry & Phase Composition*** *Main Clinker Minerals: C_3S, C_2S, C_3A, C_4AF • Roles of Each Mineral in Cement Performance • Impact of Cooling Rate & Kiln Parameters on Phase Formation • Microscopical Identification of Clinker Phases*
1215 – 1230	*Break*
1230 – 1330	***Chemical Modules in Clinker Quality*** *Lime Saturation Factor (LSF) • Silica Ratio (SR) & Alumina Ratio (AR) • Relationship to Clinker Burnability & Performance • Optimization of Modules for Different Cement Types*
1330 – 1420	***Chemical Reactions During Clinker Formation*** *Decomposition of Raw Mix Components • Solid-State Reactions in the Kiln • Liquid Phase Generation & Role in Sintering • Free Lime Formation & Clinker Quality*
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: Monday, 25th of August 2025

0730 – 0830	***Hydration of Portland Cement*** *Overview of Hydration Process • Hydration of C_3S & C_2S • C_3A & Gypsum Interaction • Hydration of C_4AF & Secondary Reactions*
0830 – 0930	***Hydration Products & their Role*** *Calcium Silicate Hydrate (C–S–H) • Calcium Hydroxide (CH) • Ettringite & Monosulfate Formation • Microstructure Development & Porosity*
0930 – 0945	*Break*
0945 – 1100	***Influence of Clinker Composition on Hydration*** *Reactivity of Silicates versus Aluminates • Effect of Cooling Rate on Clinker Reactivity • Alite/Belite Ratio & Strength Gain Pattern • Role of Free Lime & Unreacted Phases*
1100 – 1215	***Setting Time & Early Reactions*** *Factors Affecting Initial & Final Set • Flash Set & False Set Phenomena • Effect of Gypsum & Retarders • Testing Methods (Vicat Apparatus, Gillmore Needles)*
1215 – 1230	*Break*
1230 – 1330	***Heat of Hydration*** *Exothermic Nature of Hydration Reactions • Measurement Using Calorimetry • Influence of Cement Chemistry & Fineness • Relevance to Mass Pours & Thermal Cracking*
1330 – 1420	***Pozzolanic & Supplementary Cementitious Materials (SCMs)*** *Silica Fume, Fly Ash, Slag & Natural Pozzolans • Reaction with CH & Formation of Secondary C–S–H • Impact on Strength, Durability & Permeability • Chemical Considerations in Blended Cement*
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: Tuesday, 26th of August 2025

0730 – 0830	***Chemical Analysis Techniques*** *X-Ray Fluorescence (XRF) for Major Oxides • Wet Chemistry & Classical Methods • LOI & Sulfate Determination • Sample Preparation & Fusion Techniques*
0830 – 0930	***Clinker & Cement Phase Analysis*** *X-Ray Diffraction (XRD) • Rietveld Refinement for Phase Quantification • Microscopic Analysis of Clinker • SEM/EDS for Morphology & Elemental Mapping*
0930 – 0945	*Break*
0945 – 1100	***Physical Properties Affecting Quality*** *Fineness: Blaine, Laser Particle Size Analyzer • Setting Time (Initial, Final) • Soundness (Le Chatelier Method, Autoclave) • Consistency & Water Demand*
1100 – 1215	***Compressive Strength Testing*** *Standard Mortar Mix & Curing Protocols • 1, 3, 7, 28-Day Strength Development • Impact of C_3S/C_2S Ratio & Fineness • Variability Control & Troubleshooting*
1215 – 1230	*Break*
1230 – 1330	***SO_3 Optimization & Control*** *Role in Early Strength & Setting • Interaction with C_3A & Alkalis • Optimal SO_3 to C_3A Ratio • Gypsum Addition Control & Hemihydrate Effects*

1330 – 1420	***Alkalis & Chloride in Cement*** *Impact on Concrete Durability • Alkali-Silica Reaction (ASR) Risks • Chloride Limits for Reinforced Concrete • Total versus Water-Soluble Alkali Content*
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: Wednesday, 27th of August 2025

0730 – 0830	***Overview of International Cement Standards*** *ASTM C150, C595, EN 197, BS 12 • ISO 679 & ISO 9001 Integration • Strength Classes & Setting Time Limits • SO_3, MgO, Chloride & Insoluble Residue Limits*
0830 – 0930	***Statistical Quality Control (SQC)*** *Mean, Standard Deviation & Control Limits • Control Charts for Oxide Composition & Strength • Capability Indices (Cp, Cpk) • Trend Analysis & Corrective Actions*
0930 – 0945	*Break*
0945 – 1100	***Process Control Based on Chemistry*** *Real-Time Raw Mix Adjustment • Cross-Belt Analyzers & PGNAA Systems • Feedback Loops from Lab to Kiln • Blending & Proportioning Strategies*
1100 – 1215	***Quality Assurance in Cement Laboratory*** *Calibration & Standardization of Instruments • Inter-Laboratory Comparisons • Round Robin Tests & Proficiency Schemes • SOPs, Documentation & Traceability*
1215 – 1230	*Break*
1230 – 1330	***Environmental Considerations & Chemistry*** *Influence of Cement Chemistry on CO_2 Emissions • Low-Carbon Binders & SCMs • Alkali Bypass & Chlorine/Sulfur Balance • Emission Control & Material Substitution*
1330 – 1420	***Troubleshooting Quality Deviations*** *Low Early Strength: Root Causes & Remedies • Setting Problems & False Set • High Free Lime & Under-Burned Clinker • Role of Lab Data in Operational Decisions*
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: Thursday, 28th of August 2025

0730 – 0830	***Durability of Cement-Based Materials*** *Sulfate Attack & Protective Chemistry • Carbonation & pH Reduction • Chloride Penetration & Corrosion Risks • Role of C_3A, C_4AF & SCMs in Mitigation*
0830 – 0930	***Alkali-Aggregate Reaction (AAR)*** *Chemistry of Alkali-Silica & Alkali-Carbonate Reactions • Expansion Mechanisms & Gel Formation • ASTM C1260/C1567 Testing • Mitigation through SCMs & Low-Alkali Cement*
0930 – 0945	*Break*

0945 – 1040	***White & Special Cements*** *Chemical Composition for White Clinker • Low Iron & Manganese Control • Oil-Well, Rapid Hardening & Sulfate-Resisting Cements • Unique Chemical Formulations & Challenges*
1040 – 1135	***Blended Cements & Performance Optimization*** *Pozzolanic Cements (CEM II, CEM IV) • Slag Cements & Latent Hydraulic Reactions • Influence on Strength & Workability • Adjusting Clinker Chemistry for Blending*
1135 -1230	***Research Trends in Cement Chemistry*** *Belite-Rich & Belite-Sulfoaluminate Cements • Carbon-Neutral & Geopolymer Cements • Nano-Additives & their Chemical Effects • Durability-Enhancing Admixtures*
1230 – 1245	*Break*
1245 – 1345	***Workshop & Final Review*** *Case Study on Clinker & Cement Analysis • Cement Mix Design for Target Properties • Final Quiz & Group Discussion • Course Evaluation & Certification*
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*

Practical Sessions

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

Course Coordinator

Mari Nakintu, Tel: +971 2 30 91 714, Email: mari1@haward.org