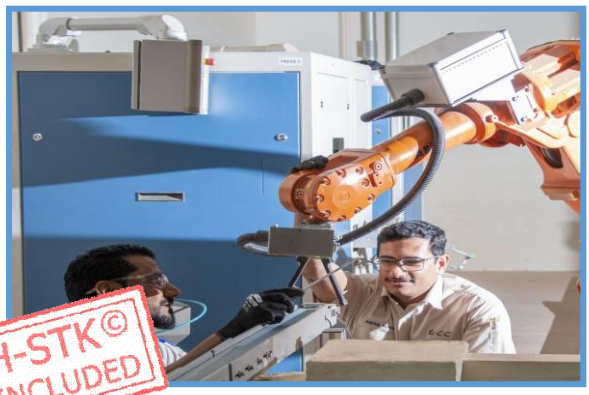
COURSE OVERVIEW PE1054
Advanced Cement Technology: Chemistry, Manufacturing & Testing

Course Title
Advanced Cement Technology: Chemistry, Manufacturing & Testing



Course Date/Venue
Session 1: June 29-July 03, 2025/Tamra Meeting Room, Al Bandar Rotana Creek, Dubai, UAE
Session 2: December 07-11, 2025/Tamra Meeting Room, Al Bandar Rotana Creek, Dubai, UAE

Course Reference
PE1054

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 Advanced Cement Technology: Chemistry, Manufacturing & Testing. It covers the cement chemistry covering major chemical constituents, cement chemistry notation, role of minor oxides and effect of trace elements on clinker and cement; the clinker mineralogy, phase development, chemical moduli, raw mix design, solid state and clinker formation reaction as well as raw material selection, chemical impacts and blended cement chemistry; and the pyroprocessing optimization, clinker cooling, heat recovery, grinding systems and energy efficiency.

Further, the course will also discuss the sulfur, alkali, chloride balancing, SO_3 control and gypsum optimization, process monitoring and control systems; the cement hydration mechanisms, setting and hardening reactions; measuring heat evolution and thermal gradients in mass concrete; the durability and chemical resistance and blended cement performance and hydration; and the superplasticizers and retarders interaction and cement sulfate balance with mixtures.

During this interactive course, participants will learn the chemical analysis and quality monitoring, mineralogical analysis, physical testing of cement, process and product capability analysis and testing of blended and specialty cements; the laboratory quality assurance and accreditation, low-carbon cement technologies and advanced cement blending techniques; the digitalization and industry 4.0 in cement plants; the CO_2 emissions tracking and benchmarking, alternative fuel impact on clinker and emissions; and the cement plant waste valorization and environmental product declaration.

Course Objectives

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

- Apply and gain an advanced knowledge on cement technology: chemistry, manufacturing and testing
- Discuss cement chemistry covering major chemical constituents, cement chemistry notation, role of minor oxides and effect of trace elements on clinker and cement
- Explain clinker mineralogy, phase development, chemical moduli, raw mix design, solid state and clinker formation reaction as well as raw material selection, chemical impacts and blended cement chemistry
- Carryout pyroprocessing optimization, clinker cooling, heat recovery, grinding systems and energy efficiency
- Explain sulfur, alkali, chloride balancing, SO_3 control and gypsum optimization as well as process monitoring and control systems
- Recognize cement hydration mechanisms, setting and hardening reactions as well as measure heat evolution and thermal gradients in mass concrete
- Illustrate durability and chemical resistance and blended cement performance and hydration
- Define superplasticizers and retarders interaction and cement sulfate balance with mixtures
- Carryout chemical analysis and quality monitoring, mineralogical analysis, physical testing of cement, process and product capability analysis and test of blended and specialty cements
- Discuss laboratory quality assurance and accreditation, low-carbon cement technologies and advanced cement blending techniques
- Explore digitalization and industry 4.0 in cement plants and define CO_2 emissions tracking and benchmarking, alternative fuel impact on clinker and emissions as well as cement plant waste valorization and environmental product declaration

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 process engineering clinker and cement grinding for

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:

Dr. John Petrus, PhD, MSc, BSc, is a **Senior Process & Petroleum Engineer** with over **30 years** of **onshore & offshore** experience within the **Oil & Gas**, **Refinery** and **Petroleum** industries. His wide experience covers in the areas of **Gas Sweetening Process** at Upstream Oil & Gas, **De-Sulfurization** Technology, **Process Troubleshooting**, **Distillation Towers**, **Fundamentals of Distillation** for Engineers, Vacuum **Distillation**, **Distillation Column** Operation & Control, **Oil Movement** Storage & Troubleshooting, **Process Equipment** Design, Applied **Process Engineering** Elements, **Process Plant** Optimization, **Revamping & Debottlenecking**, **Process Plant** Troubleshooting & Engineering Problem Solving, **Process Plant** Monitoring, **Catalyst** Selection & Production Optimization, Operations Abnormalities & Plant Upset, **Process Plant** Start-up & Commissioning, **Clean Fuel** Technology & Standards, Flare, Blowdown & Pressure Relief Systems, **Oil & Gas Field Commissioning** Techniques, **Pressure Vessel** Operation, **Gas Processing**, **Chemical** Engineering, **Process Reactors** Start-Up & Shutdown, **Gasoline Blending** for Refineries, **Urea Manufacturing** Process Technology, Continuous Catalytic Reformer (**CCR**). Further he is also well versed in **Formation Damage & Acid Stimulation**, **Production Technology** & Engineering, **Well Completions**, **Well Logs**, **Well Stimulation** & **Production Logging**, **Well Completion** Design & Operation, Well Surveillance, **Well Testing**, **Well Stimulation** & Control and **Workover** Planning, **Completions & Workover**, Hole Cleaning & Logging, Servicing and **Work-Over** Operations, **Wellhead** Operations, Maintenance & Testing, Petrophysics/Interpretation of Well Composite, **Reservoir & Tubing** Performance, Practical **Reservoir** Engineering, Clastic **Exploration & Reservoir Sedimentology**, **Carbonate Reservoir Characterization** & Modeling, **Seismic Interpretation**, **Mapping & Reservoir** Modelling, **Reservoir Geology**, Integrating **Geoscience** into **Carbonate Reservoir** Management, **Faulted & Fractured Reservoirs**, **Fractured Hydrocarbon Reservoirs**, Analyses, Characterisation & Modelling of **Fractured Reservoirs & Prospects**, **Fracture Reservoir** Modeling Using **Petrel**, **Reservoir** Engineering Applied Research, **Artificial Lift**, **Artificial Lift System** Selection & Design, Electrical Submersible Pumps (**ESP**), Enhance Oil Recovery (**EOR**), **Hydraulic Fracturing**, **Sand Control** Techniques, **Perforating** Methods & Design, **Perforating** Operations, **Petroleum** Exploration & Production, **Hydrocarbon Exploration** & Production, Exploration & Production, **Play Assessment & Prospect Evaluation**, **Formation** Evaluation, **Petroleum Engineering** Practices, **Petroleum** Hydrogeology & Hydrodynamics, **Project** Uncertainty, Decision Analysis & Risk Management, **Decision Analysis & Uncertainty** Management, **Exploration & Development Geology**, **Sedimentology & Sequence Stratigraphy**, **Structural Interpretation** in Exploration & Development, **Petrel Geology**, **Geomodeling**, **Structural Geology**, **Applied Structural Geology** in Hydrocarbon Exploration, **Petrophysics** and **Geology** of the Oil & Gas Field.. Further, he is also well-versed in **seismic interpretation**, **mapping** & **reservoir modelling tools** like **Petrel** software, **LandMark**, **Seisworks**, **Geoframe**, **Zmap** and has extensive knowledge in MSDos, Unix, **AutoCAD**, MAP, Overlay, Quicksurf, 3DStudio, **Esri ArcGIS**, Visual Lisp, Fortran-77 and Clipper. Moreover, he is a world **expert** in **analysis** and **modelling** of **fractured prospects** and **reservoirs** and a **specialist** and **developer** of **fracture modelling software tools** such as FPDM, FMX and DMX Protocols.

During his career life, Dr. Petrus held significant positions and dedication as the **Executive Director**, **Senior Geoscience Advisor**, **Exploration Manager**, **Project Manager**, **Manager**, **Process Engineer**, **Mechanical Engineer**, **Maintenance Engineer**, **Chief Geologist**, **Chief** of **Exploration**, **Chief** of **Geoscience**, **Senior Geosciences Engineer**, **Senior Explorationist**, **Senior Geologist**, **Geologist**, **Senior Geoscientist**, **Geomodeller**, **Geoscientist**, **CPR Editor**, **Resources Auditor**, **Project Leader**, **Technical Leader**, **Team Leader**, **Scientific Researcher** and **Senior Instructor/Trainer** from various international companies and universities such as the Dragon Oil Holding Plc., ENOC, MENA, ENI Group of Companies, Ocre Geoscience Services (OGS), Burren RPL, Ministry of Oil-Iraq, Eni Corporate University, Standford University, European Universities, European Research Institutes, NorskHydro Oil Company, Oil E&P Companies, just to name a few.

Dr. Petrus has a **PhD** in **Geology** and **Tectonophysics** and **Master** and **Bachelor** degrees in **Earth Sciences** from the **Utrecht University**, **The Netherlands**. Further, he is a **Certified Instructor/Trainer**, a **Certified Trainer/Assessor/Internal Verifier** by the **Institute of Leadership & Management** (**ILM**), a Secretary and Treasurer of Board of Directors of Multicultural Centre, Association Steunfonds SSH/SSR and Founding Member of Sfera Association. He has further published several scientific publications, journals, research papers and books and delivered numerous trainings, workshops, courses, seminars and conferences 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 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 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	***Fundamentals of Cement Chemistry*** *Major chemical constituents (CaO, SiO_2, Al_2O_3, Fe_2O_3) • Cement Chemistry Notation (C, S, A, F, H) • Role of Minor Oxides (MgO, SO_3, Alkalis) • Effect of Trace Elements on Clinker and Cement*
0930 – 0945	*Break*
0945 – 1030	***Clinker Mineralogy & Phase Development*** *Clinker Phases: C_3S, C_2S, C_3A, C_4AF • Alite versus Belite: Reactivity and Strength Contributions • Role of Cooling Rate on Phase Stability • Effects of Sulfate, Alkali and Minor Constituents*
1030 – 1130	***Chemical Moduli & Raw Mix Design*** *Lime Saturation Factor (LSF) • Silica Ratio (SR) and Alumina Ratio (AR) • Burnability Index and Free Lime Control • Raw Mix Optimization for Kiln Performance*
1130 – 1215	***Solid-State & Clinker Formation Reactions*** *Raw Mix Reactions through Temperature Zones • Decarbonation and Solid-Solid Reactions • Liquid Phase Generation and Sintering Behavior • Clinker Crystallization Mechanisms*
1215 – 1230	*Break*

1230 – 1330	***Raw Material Selection & Chemical Impacts*** *Variability in Limestone, Clay, Shale, Iron Ore • Influence of Impurities (Chloride, Phosphate, Potassium) • Correction Materials and Quality Assurance • Sampling and Blending Strategies*
1330 – 1420	***Blended Cement Chemistry*** *Pozzolanic, Latent Hydraulic and Filler Effects • Interaction with Clinker Phases • Impact on Hydration Kinetics and Durability • Chemical Compatibility with Admixtures*
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	***Pyroprocessing Optimization*** *Thermal Profile of Preheater, Precalciner and Kiln • Kiln Burning Zone Stability • Fuel Types and Their Combustion Chemistry • Coating and Ring Formation Chemistry*
0830 – 0930	***Clinker Cooling & Heat Recovery*** *Grate and Rotary Cooler Systems • Role of Cooling Rate in Phase Stabilization • Heat Recovery and Secondary Air Systems • Cooler Performance and Clinker Reactivity*
0930 – 0945	*Break*
0945 – 1100	***Grinding Systems & Energy Efficiency*** *Ball Mill versus Vertical Roller Mill (VRM) Design • Grinding Aids and Their Chemical Function • Cement Fineness and Hydration Rate Relationship •* *Energy Optimization Strategies*
1100 – 1215	***Sulfur, Alkali & Chloride Balancing*** *Kiln Volatile Cycle Chemistry • Kiln Inlet and Riser Buildup Analysis • Alkali Bypass System Design and Impact • Managing sulfur and Chloride Inputs*
1215 – 1230	*Break*
1230 – 1330	***SO_3 Control & Gypsum Optimization*** *Types of gypsum: dihydrate, hemihydrate, anhydrite • Cement Setting Regulation • Impact of Under- and Over-Sulfation • Measurement and Quality Control of SO_3*
1330 – 1420	***Process Monitoring & Control Systems*** *Role of real-time Analyzers (PGNAA, Cross-Belt XRF) • SCADA and Advanced Control Systems • Feedback and Feed Forward Controls • Integration of Quality Data with Process Control*
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	***Cement Hydration Mechanisms*** *Hydration of C_3S and C_2S (C–S–H formation) • Role of C_3A in Ettringite and Monosulfate Formation • Hydration of C_4AF and Role of Iron • Kinetics of Heat Release and Strength Gain*
0830 – 0930	***Setting & Hardening Reactions*** *Initial and Final Setting: Contributing Reactions • False Set versus Flash Set Mechanisms • Role of Retarders and Accelerators • Influence of Cement Fineness and Admixtures*
0930 – 0945	*Break*
0945 – 1100	***Heat of Hydration & Thermal Management*** *Measuring Heat Evolution (Calorimetry Methods) • Thermal Gradients in Mass Concrete • Cement Chemistry and Thermal Performance • Strategies for Low-Heat Cement Formulations*
1100 – 1215	***Durability a Chemical Resistance*** *Sulfate attack and SRC Formulation • Alkali-Silica Reaction (ASR) Chemistry and Mitigation • Carbonation and Steel Reinforcement Protection • Chloride Penetration and Binding*
1215 – 1230	*Break*
1230 – 1330	***Blended Cement Performance & Hydration*** *Slag, Fly Ash, Silica Fume: Reaction Products • Contribution to Later-Age Strength • Pozzolanic Activity Index (PAI) • Effect on Permeability and Durability*
1330 – 1420	***Admixtures & Compatibility*** *Superplasticizers and Retarders Interaction • Admixture-Cement Compatibility Tests • Cement Sulfate Balance with Admixtures • SCM-Admixture Synergy and Risks*
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 Analysis & Quality Monitoring*** *XRF for Major Oxides – Calibration and Drift Correction • Wet chemical Methods for SO_3, Alkalis, Chloride • LOI and Free Lime Measurements • Sample Preparation: Fusion and Pressed Pellets*
0830 – 0930	***Mineralogical Analysis*** *XRD and Rietveld Refinement for Phase Quantification • Clinker Microscopy (Optical and SEM) • SEM/EDS for Cement Hydration Products • Identifying Clinker Defects and Secondary Phases*
0930 – 0945	*Break*
0945 – 1100	***Physical Testing of Cement*** *Blaine Fineness and Particle Size Distribution • Setting time (Vicat apparatus) • Soundness Tests (Le Chatelier, Autoclave) • Compressive Strength Development (Mortar Cubes)*
1100 – 1215	***Process & Product Capability Analysis*** *Standard Deviation and Variability Control • Cp, Cpk and Statistical Control Limits • Control Charts for Strength and SO_3 • Interpreting Test Data for Process Feedback*
1215 – 1230	*Break*

1230 – 1330	***Testing of Blended & Specialty Cements*** *Strength, Setting, and Heat Evolution • Durability testing (sulfate resistance, ASR Expansion) • Water Demand and Flowability Tests • Chemical Analysis of SCMs*
1330 – 1420	***Laboratory Quality Assurance & Accreditation*** *Lab Management and ISO 17025 Requirements • Calibration and Verification of Lab Instruments • Round-Robin Testing and Inter-Laboratory Comparisons • SOPs and Training for Consistency*
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	***Low-Carbon Cement Technologies*** *Reduction of Clinker Factor • Limestone Calcined Clay Cement (LC^3) • Belite-Rich and Sulfoaluminate Cements • Carbon Capture and Utilization (CCU)*
0830 – 0930	***Advanced Cement Blending Techniques*** *Ternary Blends and Performance optimization • Intergrinding versus Interblending: Chemical Effects • Recycled Materials and Industrial Byproducts • Regulatory and Standard Compliance*
0930 – 0945	*Break*
0945 – 1100	***Digitalization & Industry 4.0 in Cement Plants*** *Predictive Analytics and AI in Quality Control • Use of Digital Twins for Process Optimization • Sensor Integration and Smart Monitoring • Digital Laboratory and LIMS Systems*
1100 – 1230	***Case Studies in Cement Optimization*** *Clinker Chemistry Adjustment for Cost Reduction • Kiln Performance Tuning Through Raw Mix Changes • Grinding aid Dosage versus Cement Performance • Troubleshooting Setting Or Strength Inconsistencies*
1230 – 1245	*Break*
1245 – 1345	***Sustainability Metrics & Circular Economy*** *CO_2 Emissions Tracking and Benchmarking • Alternative Fuel Impact on Clinker and Emissions • Cement Plant Waste Valorization • Environmental Product Declarations (EPDs)*
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

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