Chemical Reactor Design and Catalytic Process Optimization Training Course

02 - 06 Nov 2026

Cape town

4600 € (Per Person)

Ref: #ACE3147_296206

Course Introduction / Overview:

This intensive training course provides a comprehensive exploration of chemical reactor design and the optimization of catalytic processes, essential disciplines at the heart of the chemical industry. The curriculum is meticulously structured to bridge the gap between theoretical principles and practical industrial application. Drawing upon foundational concepts established by pioneers like Octave Levenspiel in his seminal work, "Chemical Reaction Engineering," this course delves into reaction kinetics, thermodynamics, and the mechanics of various reactor types. Participants will gain a deep understanding of how to select, design, and operate chemical reactors for maximum efficiency, safety, and profitability. At BIG BEN Training Center, we emphasize a hands-on approach, enabling attendees to master catalyst selection, understand deactivation mechanisms, and apply advanced modeling techniques for process intensification and troubleshooting. This program is designed not just to impart knowledge but to cultivate the critical thinking skills necessary to innovate and solve complex challenges in modern chemical manufacturing, ensuring processes are both economically viable and environmentally sustainable.

Target Audience / This training course is suitable for:

- Chemical Engineers.
- Process Development Chemists.
- R&D Scientists and Researchers.
- Production and Plant Engineers.
- Operations Managers.
- Technical Service Engineers.
- Process Safety Professionals.
- Project Engineers involved in plant design and scale-up.

Target Sectors and Industries:

- Petrochemicals and Refining.
- Pharmaceuticals and Biotechnology.
- Specialty and Fine Chemicals Manufacturing.
- Polymer and Plastics Production.
- Agrochemicals and Fertilizers.
- Environmental Engineering and Waste Treatment.
- Governmental regulatory and environmental agencies.
- Food and Beverage Processing.

Target Organizations Departments:

- Research and Development (R&D).
- Process Engineering and Design.
- Manufacturing and Production.
- Operations and Plant Management.
- Technical Services.
- Quality Assurance and Quality Control (QA/QC).
- Health, Safety, and Environment (HSE).
- Project Management.

Course Offerings:

By the end of this course, the participants will have able to:

- Analyze and apply principles of chemical kinetics and thermodynamics to reactor design.
- Design and evaluate the performance of ideal and non-ideal reactors, including CSTRs, PFRs, and batch reactors.
- Select appropriate catalysts for specific chemical transformations based on activity, selectivity, and stability.
- Understand the mechanisms of catalyst deactivation and develop effective regeneration strategies.
- Apply process modeling and simulation techniques to optimize reactor performance and yield.
- Troubleshoot common operational problems in industrial chemical reactors.
- Implement process intensification strategies to improve efficiency and reduce environmental impact.
- Conduct rigorous safety analyses for chemical reactor systems.
- Scale up reactor designs from laboratory and pilot-plant data to full industrial production.
- Evaluate the economic feasibility of different reactor configurations and catalytic processes.

Course Methodology:

The training methodology at BIG BEN Training Center is designed to be highly interactive, engaging, and directly applicable to real-world challenges. This course moves beyond traditional lectures to foster a dynamic learning environment where participants actively engage with the material. The program is built upon a foundation of expert-led instruction, supplemented by a rich blend of practical case studies from diverse sectors like petrochemicals and pharmaceuticals. Participants will work in collaborative groups on problem-solving workshops, applying theoretical concepts to design and troubleshoot reactor systems. Interactive sessions, facilitated discussions, and Q&A segments ensure that complex topics are thoroughly understood. A significant portion of the course is dedicated to simulation exercises and data analysis, allowing attendees to model reactor behavior and test optimization strategies in a controlled setting. Continuous feedback from the instructor and peers is integrated throughout the five days, ensuring a robust and practical learning experience that equips participants with immediately applicable skills.

Course Agenda (Course Units):

Unit One: Fundamentals of Chemical Reaction Engineering

- Introduction to Chemical Reactor Design.
- Reaction Kinetics, Rate Laws, and Stoichiometry.
- Thermodynamic Constraints on Chemical Reactions.
- Design of Ideal Isothermal Reactors: Batch, CSTR, and PFR.
- Sizing and Comparing Ideal Reactors.
- Analysis of Multiple Reactor Systems.
- Temperature and Pressure Effects on Reaction Rates.

Unit Two: Heat Transfer and Non-Ideal Reactor Analysis

- Energy Balances and Design of Non-isothermal Reactors.
- Steady-State and Unsteady-State Reactor Operation.
- Heat Effects and Reactor Stability Analysis.
- Residence Time Distribution (RTD) for Non-Ideal Reactors.
- Modeling Real Reactors using RTD Data.
- Dispersion and Tanks-in-Series Models.
- Mass Transfer Limitations in Reaction Systems.

Unit Three: Principles of Heterogeneous Catalysis

- Introduction to Catalytic Processes and Catalyst Types.
- Adsorption, Desorption, and Surface Reaction Steps.
- Langmuir-Hinshelwood-Hougen-Watson (LHHW) Kinetics.
- Catalyst Preparation and Characterization Techniques.
- External and Internal Diffusion Effects in Porous Catalysts.
- The Thiele Modulus and Effectiveness Factor.
- Designing Catalysts for Selectivity and Activity.

Unit Four: Catalytic Reactor Design and Process Optimization

- Design of Fixed-Bed Catalytic Reactors.
- Design of Fluidized-Bed and Slurry Reactors.
- Analysis of Catalyst Deactivation Mechanisms: Sintering, Poisoning, and Coking.
- Strategies for Catalyst Regeneration.
- Reactor Scale-Up Principles and Challenges.
- Process Intensification Techniques in Reactor Engineering.
- Case Studies: Ammonia Synthesis, Fluid Catalytic Cracking (FCC).

Unit Five: Advanced Topics, Safety, and Sustainability

- Introduction to Multiphase Reactor Design.
- Computational Fluid Dynamics (CFD) for Reactor Modeling.
- Process Safety Management (PSM) for Chemical Reactors.
- Hazard Identification and Risk Assessment (HAZOP).
- Green Chemistry Principles in Reactor Design.
- Sustainable Catalysis and Biocatalysis.
- Future Trends in Reactor Technology and Catalytic Processes.

FAQ:

Qualifications required for registering to this course?

There are no requirements.

How long is each daily session, and what is the total number of training hours for the course?

This training course spans five days, with daily sessions ranging between 4 to 5 hours, including breaks and interactive activities, bringing the total duration to 20 - 25 training hours.

Something to think about:

Considering the push towards a circular economy, how might future reactor designs and catalytic processes be fundamentally re-imagined to handle variable, recycled feedstocks instead of pure, virgin materials?

What unique qualities does this course offer compared to other courses?

This training course distinguishes itself by seamlessly integrating the foundational principles of chemical reaction engineering with the cutting-edge challenges of modern industrial practice. Unlike programs that remain purely theoretical, this course emphasizes the practical application of knowledge, focusing on how to troubleshoot, optimize, and innovate within real-world operational constraints. We move beyond standard textbook problems to analyze complex industrial case studies, exploring the nuances of catalyst deactivation, non-ideal reactor behavior, and process scale-up. The curriculum uniquely bridges the gap between the R&D lab and the production plant, equipping participants with the skills to translate novel catalytic discoveries into efficient, safe, and profitable large-scale processes. Furthermore, the course incorporates critical contemporary themes such as process intensification, sustainability, and the application of advanced modeling tools like CFD. This holistic approach ensures that participants not only master the core science but also develop a strategic perspective on designing the next generation of chemical processes.