

Advanced Chemical Reactor Design and Operations Training Course

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Overview

Advanced Chemical Reactor Design and Operations Training Course is a one-week advanced programme for chemical and process engineers, reactor specialists, production technologists, operations leaders and process-safety professionals. Participants connect reaction kinetics, stoichiometry, equilibrium, mass and energy balances with reactor selection, sizing, scale-up and plant performance. The course covers ideal and non-ideal behaviour, batch, continuous stirred-tank, plug-flow, packed-bed, catalytic and multiphase systems, then links design assumptions to heat removal, stability, control, catalyst condition and troubleshooting. Participants leave with a Reactor Performance and Improvement File. Agile Leaders Training Center develops advanced chemical reaction engineering capability.

Who Should Attend

- Chemical, process and reaction engineers
- Plant production and operations engineers
- Process development, scale-up and technology teams
- Control, reliability and troubleshooting specialists
- Process-safety and technical assurance professionals

Participants should understand material and energy balances and basic reaction kinetics. The course is educational and does not replace process licensor requirements, management of change or site engineering approval.

Departments and Industries

The course supports process engineering, operations, production technology, research and development, scale-up, process control, reliability and safety teams in chemicals, petrochemicals, refining, polymers, pharmaceuticals, biotechnology, water treatment and related process industries.

Learning Objectives

- Translate kinetic and thermodynamic information into reactor design decisions
- Compare batch, CSTR, PFR, packed-bed and multiphase reactor behaviour
- Use residence-time distribution to diagnose non-ideal flow
- Link heat and mass transfer limits to conversion and selectivity
- Assess thermal stability, runaway risk and control requirements
- Structure reactor scale-up, monitoring and troubleshooting
- Develop a prioritised reactor performance improvement plan

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Course Methodology

The programme uses technical briefings, design equations, simplified calculations, reactor-selection cases, residence-time plots, heat-balance exercises, operating data, cause maps and improvement workshops. Daily outputs combine into a Reactor Performance and Improvement File containing assumptions, indicators, constraints, safeguards and actions.

Day 1: Reaction Engineering Foundations and Reactor Selection

- Reaction rate, stoichiometry, equilibrium, conversion and selectivity
- Rate laws, temperature dependence and kinetic-data quality
- Material and energy balances for reacting systems
- Batch, CSTR and PFR characteristics and selection boundaries
- Building the reactor design basis and assumption register

Day 2: Non-Ideal Flow, Transport and Reactor Performance

- Residence-time distribution and tracer-response interpretation
- Dead zones, bypassing, back-mixing and axial dispersion
- Internal and external heat and mass transfer limitations
- Observed versus intrinsic kinetics and effectiveness
- Diagnosing conversion and selectivity gaps from plant data

Day 3: Catalytic, Packed-Bed and Multiphase Reactors

- Heterogeneous catalysis and surface-reaction considerations
- Packed-bed pressure drop, flow distribution and hot spots
- Catalyst deactivation, poisoning, fouling and regeneration
- Gas-liquid and gas-liquid-solid contacting behaviour
- Selecting performance indicators for advanced reactor systems

Day 4: Thermal Stability, Control and Process Safety

- Heat generation, heat removal and temperature sensitivity
- Multiple steady states, instability and runaway scenarios
- Measurement, manipulated variables and control structure
- Safeguards, alarms, interlocks and emergency response boundaries
- Managing change in reactor feed, catalyst and operating conditions

Day 5: Scale-Up, Troubleshooting and Optimisation

- Geometric, kinetic, mixing and heat-transfer scale-up constraints
- Moving from laboratory and pilot evidence to plant decisions
- Structured troubleshooting using data, hypotheses and tests
- Balancing throughput, conversion, selectivity, energy and safety
- Completing a reactor improvement roadmap and review plan

Practical Outputs

- Reactor-selection decision matrix
- Kinetic and design-assumption register
- Residence-time and non-ideal-flow diagnostic worksheet
- Thermal stability and safeguard review
- Catalyst performance cause map
- Reactor improvement roadmap

Frequently Asked Questions

Does the course focus on one reactor type?

No. It compares common ideal and industrial reactor configurations and their operating constraints.

Is advanced mathematics required?

Participants use practical engineering relationships and simplified calculations; prior familiarity with balances and kinetics is recommended.

Does the course cover process safety?

Yes. Thermal stability, runaway scenarios, safeguards, alarms and management-of-change boundaries are integrated.

Will participants use proprietary simulation software?

No. The programme is platform-neutral and focuses on engineering logic and interpretation.

What is the main workplace output?

Participants complete a Reactor Performance and Improvement File for adaptation to their plant.

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