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COURSE BROCHURE

Advanced Chemical Reactors Design and Performance Training Course

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Registered in the United Kingdom and Saudi Arabia

Advanced Chemical Reactors Design and Performance Training Course

Advanced Chemical Reactors Design and Performance is a 2-week training course for chemical engineers, reactor specialists and process development engineers who size, scale up or operate reacting systems, and it ends with a reactor performance assessment setting out conversion, selectivity and safe operating limits. The reactor decides product yield, by-product load and much of a plant's hazard profile. Jupiter Prime Training offers this course to process development and production groups.

Why Chemical Reactors Design and Performance Matters Now

Three pressures bear on the reactor. Margins depend on squeezing extra selectivity from existing catalysts and vessels rather than building new ones. Feedstocks are more variable, including recycled and bio-based streams that carry new impurities. Process safety expectations also demand that heat release and runaway margins are proven, not assumed. A plant that models its reactor well raises yield and runs closer to limits with confidence; one that does not loses product to side reactions and risks thermal incidents. The course rests on reaction kinetics, ideal reactor models such as the continuous stirred-tank reactor CSTR and plug flow reactor PFR, and residence time distribution RTD analysis.

Who Gains Most from Chemical Reactors Design and Performance

- Engineers who size reactors and choose between batch, stirred and tubular designs
- Specialists who run catalytic beds and decide on regeneration and catalyst change-outs
- Development engineers who scale reactions from laboratory to pilot and production
- Engineers who set reactor temperature, pressure and feed limits for operations
- Safety specialists who assess heat release and runaway scenarios

A process development group that sends its kinetics specialist and its plant reactor engineer together gains most, because laboratory data and plant behaviour then meet in one model.

Chemical Reactors Design and Performance Capabilities

Participants leave able to predict how a reactor will convert, select and release heat before they change its conditions.

- Calculate rate constants and activation energies from experimental data — scale-up and design decisions
- Specify reactor type and volume for a target conversion — process design reviews
- Assess non-ideal flow using tracer tests and RTD curves — diagnosis of underperforming reactors
- Design catalytic and multiphase reactor operating windows — production engineers
- Test heat removal capacity against runaway criteria — process safety reviewers
- Communicate conversion, selectivity and limit recommendations — operations and management

Key Chemical Reactors Design and Performance Terms

- Conversion — the fraction of a reactant consumed in the reactor, a primary measure of reactor performance.
- Selectivity — the ratio of desired product formed to undesired products, governing yield and separation load.
- Residence time distribution — the spread of times fluid elements spend in a reactor, revealing bypassing, dead zones or mixing.
- Damköhler number — a dimensionless ratio of reaction rate to transport rate used to judge which controls performance.
- Thermal runaway — an uncontrolled rise in temperature where heat generation outpaces heat removal, accelerating the reaction.
- Effectiveness factor — the ratio of actual catalyst pellet reaction rate to the rate without internal diffusion limits.

Chemical Reactors Design and Performance Day by Day

Day 1: Reactors in Process and Business Context

- Reactor Role in Plant Yield and Economics — Value of Selectivity Points
- Batch, Semi-Batch and Continuous Choices — Matching Production Scale
- Reaction Pathway Mapping — Desired and Competing Reactions
- Feedstock Variability and Impurities — Effects on Reactor Behaviour
- Reactor Performance Indicators — Conversion, Yield and Space-Time Yield

Day 2: Reaction Kinetics

- Rate Laws and Reaction Order — Fitting Kinetic Data
- Arrhenius Temperature Dependence — Activation Energy and Sensitivity
- Complex Reaction Networks — Series, Parallel and Reversible Steps
- Kinetic Parameter Estimation Tools — Regression and Confidence Limits
- Laboratory Reactor Types for Kinetics — Generating Reliable Data

Day 3: Ideal Reactor Design

- Batch Reactor Design Equations — Cycle Time and Productivity
- Continuous Stirred-Tank Reactor Sizing — Volume for Target Conversion
- Plug Flow Reactor Design — Length, Pressure Drop and Profiles
- Reactors in Series and Recycle — Improving Conversion and Selectivity
- Levenspiel Plots — Comparing Reactor Configurations Visually

Day 4: Non-Ideal Flow and Mixing

- Tracer Testing Methods — Pulse and Step Injection Choices
- Residence Time Distribution Curves — Detecting Bypass and Dead Volume
- Tanks-in-Series and Dispersion Models — Predicting Real Conversion
- Agitator Selection and Mixing Time — Micromixing Effects on Selectivity
- Computational Fluid Dynamics Uses and Limits — When Detailed Models Pay

Day 5: Heterogeneous Catalysis

- Catalyst Structure and Active Sites — Surface Area and Pore Size
- Adsorption-Based Rate Expressions — Langmuir-Hinshelwood Kinetics
- Internal and External Diffusion Limits — Effectiveness Factor Estimation
- Catalyst Deactivation and Regeneration — Cycle Length Decisions
- Catalyst Selection and Testing Protocols — Vendor Comparison

Day 6: Fixed and Fluidised Bed Reactors

- Fixed Bed Design and Pressure Drop — Pellet Size Trade-Offs
- Axial and Radial Temperature Profiles — Hot Spot Prediction
- Multitubular Reactor Cooling — Tube Count and Coolant Choice
- Fluidised Bed Hydrodynamics — Bubbling, Entrainment and Attrition
- Bed Loading and Distribution Practices — Avoiding Channelling

Day 7: Multiphase Reactors

- Gas-Liquid Mass Transfer Coefficients — Limiting Steps in Absorption Reactions
- Bubble Column and Sparged Tank Design — Gas Holdup and Dispersion
- Trickle Bed Reactor Wetting — Liquid Distribution and Conversion
- Slurry Reactors and Catalyst Separation — Filtration and Loss
- Polymerisation Reactor Features — Viscosity and Heat Transfer Effects

Day 8: Heat Management and Runaway Prevention

- Reactor Energy Balances — Heat Generation and Removal Curves
- Stability Criteria and Multiple Steady States — Safe Operating Points
- Reaction Calorimetry Data — Adiabatic Temperature Rise Assessment
- Runaway Scenarios and Emergency Relief — Venting and Quench Systems
- Temperature Control Strategies — Jackets, Coils and External Loops

Day 9: Scale-Up and Optimisation

- Scale-Up Rules and Dimensionless Groups — Preserving Performance at Size
- Pilot Plant Planning — Data Needed Before Commercial Design
- Reactor Modelling in Process Simulators — Linking Kinetics to Flowsheets
- Selectivity Optimisation by Temperature and Feed Policy — Yield Gains
- Reactor Revamp Options — Internals, Catalyst and Cooling Upgrades

Day 10: Practising the Reactor Performance Assessment

- Kinetic Model Fit to Plant Data — Validated Basis for Assessment
- RTD and Mixing Diagnosis — Gap Between Ideal and Actual
- Heat Removal and Runaway Margin Check — Safety Envelope Confirmation
- Conversion and Selectivity Improvement Cases — Ranked Options
- Reactor Performance Assessment — Conversion, Selectivity and Safe Operating Limits

Applying Chemical Reactors Design and Performance After the Course

- Fit a kinetic model to recent plant data for one reactor and compare predicted and actual conversion.
- Run a heat removal and adiabatic temperature rise check for a reactor and share the safety margin with operations.

Chemical Reactors Design and Performance Questions FAQ

What is chemical reactors design and performance, and why does it matter now?

Chemical reactors design and performance is the engineering of reacting vessels for target conversion, selectivity and safety. It matters now because margins depend on extra yield from existing assets while feed variability and safety expectations keep rising.

Which roles gain most from advanced chemical reactors design and performance training?

Chemical engineers, reactor specialists and process development engineers gain most. They choose reactor types, set operating limits, scale reactions and answer for yield and thermal safety.

How does advanced chemical reactors design and performance differ from a general process engineering course?

It concentrates on the reacting step alone. Participants go deep into kinetics, ideal and non-ideal models, catalysis, multiphase contact and runaway prevention instead of covering every unit operation briefly.

What do you bring back from chemical reactors design and performance training?

You bring back an assessment of a reactor you know. It includes a fitted kinetic model, a mixing diagnosis, a runaway margin check and ranked options for better conversion and selectivity within safe limits.

Chemical Reactors Design and Performance: The Way Forward

The reactor performance assessment first informs whether temperature, feed or catalyst changes can lift yield without eroding safety margins. Reactor engineers, development specialists and safety reviewers use it to agree new limits. After its first use, revisit the kinetic parameters, because catalyst ageing and feed changes slowly shift the reaction behaviour the model describes.