Reactor Scale-Up Techniques Training Course

Professional Development Training Course Outline

Category	General Training	**Duration**	5 Days
Base Fee	$1,500 USD	**Delivery Mode**	Online / On-site Hybrid

Course Introduction

The successful scale-up of chemical and biochemical reactors is a critical factor in achieving commercial manufacturing excellence, process optimization, and sustainable industrial growth. Organizations across the pharmaceutical, petrochemical, specialty chemicals, biotechnology, and energy sectors face increasing pressure to accelerate product commercialization while maintaining process safety, product quality, regulatory compliance, and operational efficiency. Reactor Scale-Up Techniques Training Course provides participants with advanced knowledge and practical skills required to bridge the gap between laboratory-scale experimentation and full-scale industrial production. The program focuses on process intensification, digital transformation, computational fluid dynamics (CFD), mixing optimization, heat transfer enhancement, and advanced reactor design methodologies.

Participants will gain hands-on exposure to modern scale-up strategies, emerging technologies, and industry best practices used in world-class manufacturing facilities. Through real-world case studies, simulation exercises, and expert-led discussions, attendees will learn how to identify scale-dependent challenges, mitigate technical risks, optimize reactor performance, improve yield and productivity, and achieve robust process scalability. The course integrates concepts from Industry 4.0, process analytical technology (PAT), artificial intelligence-driven process optimization, sustainable manufacturing, and digital twin technologies to equip professionals with future-ready competencies for successful reactor scale-up projects.

Programme Curriculum

Reactor Scale-Up Techniques Training Course

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Course Duration

5 days

Course Objectives

Upon completion of this course, participants will be able to:

1. Understand advanced principles of reactor scale-up engineering.
2. Apply computational fluid dynamics (CFD) for scale-up analysis.
3. Optimize mixing efficiency and mass transfer performance.
4. Evaluate heat transfer limitations during scale-up operations.
5. Implement Process Analytical Technology (PAT) for process monitoring.
6. Utilize Digital Twin Technology for reactor performance prediction.
7. Apply Artificial Intelligence (AI) and Machine Learning in process optimization.
8. Conduct scale-up risk assessments using Process Safety Management (PSM) principles.
9. Develop robust process intensification strategies.
10. Improve product quality through Quality by Design (QbD) methodologies.
11. Design pilot plant studies for successful commercialization.
12. Identify and troubleshoot scale-up bottlenecks and operational challenges.
13. Implement sustainable and energy-efficient reactor scale-up solutions.

Target Audience

1. Chemical Engineers
2. Process Engineers
3. Production Managers
4. Plant Operations Engineers
5. R&D Scientists
6. Bioprocess Engineers
7. Project Engineers
8. Technical Consultants and Process Specialists

Course Modules

Module 1: Fundamentals of Reactor Scale-Up

- Principles of reactor scale-up
- Geometric, kinematic, and dynamic similarity
- Scale-up criteria and dimensionless numbers
- Scale-up challenges and limitations
- Industrial scale-up roadmap
- **Case Study:** Scaling a specialty chemical reactor from laboratory to pilot plant production.

Module 2: Mixing and Hydrodynamic Scale-Up

- Mixing fundamentals and impeller selection
- Power consumption scaling
- Residence time distribution analysis
- Mass transfer coefficient optimization
- Turbulence and flow pattern characterization
- **Case Study:** Mixing optimization in a large-scale polymerization reactor.

Module 3: Heat Transfer and Thermal Management

- Heat transfer mechanisms in reactors
- Temperature control strategies
- Jacket and coil design considerations
- Hot spot prevention techniques
- Thermal runaway risk mitigation
- **Case Study:** Heat removal challenges in exothermic reaction scale-up.

Module 4: Computational Fluid Dynamics (CFD) Applications

- Introduction to CFD modeling
- Reactor flow simulation techniques
- Multiphase flow analysis
- Mixing and heat transfer prediction
- CFD validation and interpretation
- **Case Study:** CFD-based optimization of reactor geometry for improved performance.

Module 5: Process Intensification and Advanced Reactor Design

- Process intensification concepts
- Microreactor technologies
- Continuous flow reactor systems
- Modular manufacturing approaches
- Sustainable reactor design
- **Case Study:** Continuous processing implementation in pharmaceutical manufacturing.

Module 6: Digital Transformation in Reactor Scale-Up

- Industry 4.0 applications
- Digital twin implementation
- Smart manufacturing technologies
- AI-driven process optimization
- Predictive maintenance systems

- **Case Study:** Digital twin deployment for real-time reactor monitoring.

Module 7: Process Safety and Risk Management

- Process hazard analysis (PHA)
- HAZOP methodology
- Scale-up risk identification
- Safety instrumented systems (SIS)
- Regulatory compliance requirements
- **Case Study:** Prevention of thermal runaway incidents during commercial scale-up.

Module 8: Pilot Plant Validation and Commercialization

- Pilot plant design and operation
- Technology transfer strategies
- Process validation methodologies
- Performance qualification techniques
- Commercial production readiness assessment
- **Case Study:** Successful commercialization of a biotech fermentation process.

Training Methodology

This course employs a participatory and hands-on approach to ensure practical learning, including:

- Interactive lectures and presentations.
- Group discussions and brainstorming sessions.
- Hands-on exercises using real-world datasets.
- Role-playing and scenario-based simulations.
- Analysis of case studies to bridge theory and practice.
- Peer-to-peer learning and networking.
- Expert-led Q&A sessions.
- Continuous feedback and personalized guidance.

Register as a group from 3 participants for a Discount

Send us an email: info@fineskilltrainingcenter.org or call *+254769199797*

Certification

Upon successful completion of this training, participants will be issued with a globally- recognized certificate.

Tailor-Made Course

We also offer tailor-made courses based on your needs.

Key Notes

a. The participant must be conversant with English.

b. Upon completion of training the participant will be issued with an Authorized Training Certificate

c. Course duration is flexible and the contents can be modified to fit any number of days.

d. The course fee includes facilitation training materials, 2 coffee breaks, buffet lunch and A Certificate upon successful completion of Training.

e. One-year post-training support Consultation and Coaching provided after the course.

f. Payment should be done at least a week before commence of the training, to Fineskill Training Center account, as indicated in the invoice so as to enable us prepare better for you.

Upcoming Scheduled Sessions

Start Date	End Date	Location	Price
23 Nov 2026	27 Nov 2026	Online	$1,000
23 Nov 2026	27 Nov 2026	Physical	$1,500
23 Nov 2026	27 Nov 2026	Physical	$3,000
23 Nov 2026	27 Nov 2026	Physical	$3,000
23 Nov 2026	27 Nov 2026	Physical	$6,000
23 Nov 2026	27 Nov 2026	Physical	$4,500
23 Nov 2026	27 Nov 2026	Physical	$6,000
23 Nov 2026	27 Nov 2026	Physical	$6,000

Ready to enroll or request a customized program? Book online or contact us:

Register Online Now

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