PE02: Design, Engineering, and Scale-Up of Fixed-Bed Reactors (Single-Phase and Trickle-Phase)

How can we….

- design and size fixed bed reactors to achieve the right hydrodynamics and pressure drop performance?
- design and size single-phase fixed bed reactors correctly to achieve desired conversion and performance?
- design and size mixed-phase (trickle-phase) fixed bed reactors correctly to achieve desired conversion and performance?
- design the inlet and outlet distributors and specify internal hardware correctly?
- scale up directly from lab to commercial reactor?
- predict commercial reactor performance using lab reactor data?

If you need answers to the above questions, please attend our course.

Date: 2 Days Course - Check upcoming dates in www.chemengedu.com

Time: 9:00-17:00

Price & Promotions: See rate and promotions in www.chemengedu.com

Venue: Check venue in www.chemengedu.com

Registration: By Training Registration Page in www.chemengedu.com or contact Khun Piyarat 089 118 6531, chemengedu.training@gmail.com

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Agenda & Course Outline:

Day 1:

8:00 AM – 9:00 AM Register

9:00 AM – 12:00 PM

I. Fixed Bed Reactor Introduction
- Types and Selection of Commercial Fixed Bed reactors
  - By reaction phases
  - By reactor design

12:00 PM – 13:00 PM Lunch Break

13:00 PM – 17:00 PM

II. Single-Phase Fixed Bed Reactor Design
- Applications
- Basic Design Considerations
  - Catalyst shapes
  - Particle diameter and void fraction
  - Bed L/D ratio
  - Standard shell diameter

- Fluid flow and contacting
- Maximum allowable pressure drop
- Inert fill
- Fixed bed fouling
- Bed lifting
- Inlet distributor
- Outlet collector

- Catalyst loading and unloading
- Sock loading vs. dense loading
- Example Loading Diagram
- Unloading practices: catalyst dump nozzles, dry vs. wet vs. vacuum unloading

Day 2:

8:00 AM – 9:00 AM Register

9:00 AM – 12:00 PM

III. Single-Phase Fixed Bed Reactor Scale-Up

- Background on heterogeneous catalytic reactions
  - Bulk diffusion effects (interphase mass transfer in packed bed)
  - Pore diffusion effects (effectiveness factor)
- Reaction Regimes
- Methods and equipment to develop design data for scale-up
- Fixed bed reactor design and scale-up strategies
  - Reaction pressure and temperature
  - Selectivity vs. conversion
  - Concentration and composition
- Reaction Thermodynamic Analysis for Initial Design
  - Concepts of reactor modeling in process simulator
  - Analysis of Real Reactor Examples
- Approach to plug flow: effects of residence time and backmixing on conversion
- How to approach plug flow and minimize mass & heat transfer effects
- Example on scaling up fixed bed reactors by rate-limiting steps

12:00 PM – 13:00 PM Lunch Break

13:00 PM – 17:00 PM

IV. Mixed-Phase (Trickle Phase) Fixed Bed Reactor Design

- Applications
- Basic Design Considerations
  - Fluid Flow and Contacting
  - Fixed Bed Fouling
  - Inlet Distributor
  - Liquid redistribution
  - Interbed quenching and mixing of fluids
  - Pressure drop optimization
  - Bed Lifting
  - Catalyst dump tubes
  - Techniques for removing particulates from the feed
  - Techniques to mitigate fouling

V. Hydrotreater Reactor Design Examples
- Overview & Theory
  - Hydrotreating Theory
  - Liquid wetting on catalysts
  - Mass transfer effects
  - Hydrogen solubility in liquid (hydrogen partial pressure)
- Technology Overview
- Catalysts and Hardware

Your Instructor:

Mr. Wiroon Tanthapanichakoon,
- Senior licensed chemical engineer in Thailand, license no. 155
- Commitee of Engineering Institute of Thailand in Chemical and Petrochemical, license no. 2/043447

Qualifications:

- **Managing Director and Technology Director of Global R&D Co. Ltd. (www.globalrd.co.th)**
- **The founder of online chemical & engineering education platform: www.chemengedu.com, www.facebook.com/chemengedu2015**
- **Invited lecturers and instructors for various technical seminars by providing over 100+ courses for > 130+ organizations and > 1500+ engineers in Thailand and other countries proven by 50% participants are the repeating customers.**
- Bachelor and Master degrees in Chemical Engineering from Kyoto University, Japan
- >10-year experience in a refinery of a global oil company and an ethylene plant of a leading Thai petrochemical company with direct experience in process and equipment design
- 1-year work experience in USA in a technology team of a well-known US technology licensor, GTC Technology US LLC
- A member of Elsevier Editorial Board in Process and Plant Design (2014-2015) and an advisory board member of International Association of Certified Practicing Engineers (IACPE) (2015-2016)
- A Senior Member of American Institute of Chemical Engineers (AIChE)
- One of the first Thai chemical engineers to have published articles in 3 renowned chemical engineering monthly magazines in the US – i.e. *Chemical Engineering Progress* (by AIChE), *Chemical Engineering* Magazine, *Hydrocarbon Processing*
- Holds several papers on Sciencedirect and technology patents
- Presented papers at AIChE 2006 Fall Meeting and was the first engineer of his Thai leading company to present technical knowledge at AIChE 2015 Spring Meeting: Ethylene Producers' Conference
- Wiroon's technology co-development & scale-up experience with renowned experts:

Experiences as an Invited Lecturer or Course Instructor

1) Mass Transfer and Mass Transfer Devices Scale-Up (Nov'10, SCG Chemicals)
2) Accelerating Process and Product Development (Jul'12, GTC Technology)
3) Process Design and Optimization, Distillation Design, Heat Transfer and Heat Exchanger Design, Heat Integration, Basic Costing, and Steps After Basic Process Design (Jan-Feb'13, Naresuan)
4) Chemical Process Scale-Up (Jun'13, Chulalongkorn)
5) Process Plant Design Course (Oct-Dec'13, Naresuan)
6) Fixed-Bed Reactor Scale-Up Seminar (Aug'14, Chulalongkorn)
7) Process Innovation and Process Engineering from the Industrial Point of View (Sep'14, KMITL Ladkrabang)
8) Fluid Flow and Hydraulics (Jan'15, SCG Academy)
9) Fixed-Bed Reactor Design and Scale-Up (Mar'15, Chulalongkorn)
10) Wiroon T. et al., "Analysis and Optimization of High-Emissivity Coil Inserts to Improve Overall Coil Heat Transfer", 2015 AIChE 27th Ethylene Producers' Conference (Apr'15)
11) Fixed-Bed Reactor Design and Engineering (Aug'15, SCG Academy)
12) Technical Writing & Presentation for Professionals (Mar'16, Technology Promotion Association)
13) Scale-Up in Chemical Engineering (Feb'16, VISTEC)
14) "High Throughput Reactors", Singapore Catalyst Society Conference (May'16)
15) "Presentation and Writing Skills", Grand Siam Composite (Feb'16)
16) PE04: What Engineers Should Understand to Develop Correct PFD, P&ID, and PES (May'16)
17) Presentation Skills, CUEL Co. Ltd. (June'16)
18) GC01: Professional Presentation and Writing Skills (Aug'16)
19) PE07: Basic Design and Process Engineering Skills for Engineers (Sep'16)
20) PE04: P&ID and Piping Engineering Specifications (SCG Chem, Sep'16)
21) Professional Presentation and Writing Skills (TPA, Sep'16)
22) PE01: Fluid Flow and Hydraulic Analysis (Oct'16)
23) PE07: Basic Design and Process Engineering Skills for Engineers (Sep'16)
24) High Impact Presentation and Writing Skills (Nov'16, MJ Swagelok)
25) Lab Research to Innovation Business (Nov'16, NIA)
26) PE04: P&ID and Piping Engineering Specifications (Nov'16)
27) PE12: Polymer Extrusion and Compounding Technology (Nov'16)
28) PE11: Fluid Mixing and Agitated Tank Reactor Design & Scale-Up (Jan'17)
29) "Creating Impacts from Scale-Up" (Feb'17, PACCON)
30) PE09: Shell-and-Tube Heat Exchanger Design, Specification, Sizing (Feb'17)
31) PE07: Basic Design and Process Engineering Skills for Engineers (Mar'17)
32) GC01: High-Impact Technical Journal Writing (SCG, Mar'17)
33) PE04: P&ID and Piping Engineering Specifications (Apr'17)
34) PE13: Process Operation & Engineering Problem Solving (Apr'17)
35) PE02: Fixed Bed Reactor Design, Engineering, and Scale-Up (VISTEC, May'17)
36) Scale Up Process to Create Tangible Impact from Commercialization (PETROMAT, May'17)
37) Applying Thermodynamic Knowledge to Real-World Problem Solving (Mar'16, KMUTNB)
38) Essential Excel Spreadsheet Skills for Chemical Process Engineers (Apr'16, KMUTNB)
39) CU Process Design and PFD-P&ID Course (Jun'17)
40) E851B: PFD-P&ID-Piping Engineering Specs (Jul'17)
41) Scale-Up to Make Tangible Impacts from Research (Jul'17, TRF Congress)
42) GE01: Capital and Operation Cost Estimation (Sep'17)
43) Process Scale-Up Course (PTTGC, Sep'17)
44) Fluid Mixing Design and Scale-Up (PTTGC, Oct'17)
45) PE07: Process Design and Basic Engineering Skills for Engineers (Nov'17)
46) PE13: Process Engineering & Problem Operation Problem Solving and Troubleshooting (IRPC, Nov'17)
47) PE01: Fluid Flow and Hydraulic Analysis for Engineers (Nov'17)
48) PE04: PFD-P&ID-Piping Engineering Specifications (Dec'17)
45) PE13: Process Operation & Engineering Problem Solving (Oct'17)
46) PE12: Polymer Extrusion and Compounding Technology (Oct'17)
47) PE07: Basic Design and Process Engineering Skills for Engineers (Nov'17)
48) PE01: Fluid Flow and Hydraulic Analysis (Nov'17)
49) PE17: Process Integration and Pinch Analysis (Nov'17)
50) PE04: P&ID and Piping Engineering Specifications (Dec'17)
51) EXXX: Fluid Flow and Hydraulic Analysis (Dec'17, PTTGC)
52) E851B: P&ID and Piping Engineering Specifications (Dec'17, BANGCHAK)

53) E822B: Advanced Principles of Fluid Flow and Hydraulic Analysis (Bangchak, Jan'17)
54) PE09: Heat Exchanger Design, Sizing, Rating, and Specifications (Feb'18)
55) PE05: Distillation Process and Equipment Design, Sizing, Troubleshooting (Mar'18)
56) PE07: Advanced Process Design and Basic Engineering Skills (Bangchak, Mar'18)
57) PE13: Process Operation and Equipment Problem Solving &Troubleshooting (Apr'18)
58) PE18: Pressure Relief System Design & Sizing: PSV, Flare, Depressuring (Apr'18)
59) PE01: Fluid Flow and Hydraulic Analysis (May'18)
60) PE07: Advanced Principles of Process Design and Basic Engineering (May'18)
61) GC01: High-Impact Technical Presentation and Writing for Professionals (Jun'18)
62) PE04: Principles to Develop PFD, P&ID and Piping Engineering Specifications (Jun'18)
63) GE02: Advanced Process Engineering & Problem Solving Using Excel Spreadsheets & Solvers (Jul'18)
64) PE11: Fluid Mixing and Agitated Mixing Tank Reactor Design, Engineering and Scale-Up (Aug'18)
65) GE01: Capital and Operating Cost Estimation and Project Economics for Process Plants (Aug'18)
66) PE09: Heat Exchanger Design, Specification, Rating and Sizing (Aug'18)
67) How to Accelerate Success as an Engineer (Aug'18, PTTEP)
68) PE21: Practical Energy Efficiency and Optimization for Process Industries (Sep'18)
69) PE10: Pump and Compressor Systems Engineering Design, Specification, Sizing (Sep'18)
70) PE13: Process Equipment & Operation Problem Solving, Troubleshooting (Oct'18)
71) PE20: Waste Reduction-Reuse-Recycling Technologies and Resource Optimization Techniques (Oct'18, IRPC)
72) GE01: Capital and Operating Cost Estimation and Project Economics for Process Plants (Oct'18, PTTGC)
73) PE07: Advanced Principle of Process Design and Basic Engineering of Process Plants (Nov'18, PTTGSP)
74) Making Incredible Impacts as a Chemical Engineer by Innovation and Scale-up (Dec'18, Mahidol University)
75) PE01: Fluid Flow and Hydraulic Analysis for Engineers (Dec'18)
76) PE04: Principles to Develop PFD, P&ID and Piping Engineering Specifications (Dec'18)
77) Heat Exchanger Maintenance Knowledge Sharing and Machine Learning (Jan'19, INSR)
78) Technical Problem Solving with Excel Spreadsheet and Solver Skills (Feb'19, KMUTNB)
79) PE09: Heat Exchanger Design, Specification, Rating and Sizing (Feb'19)
80) What makes Great Engineers with Continuous Innovations? (Feb'19, SCG Chemical)
81) GE01: Capital and Operating Cost Estimation and Project Economics for Process Plants (Mar'19)
82) PE01: Fluid Flow and Hydraulic Analysis for Engineers (Mar'19, UBE Chemical)
83) PE13: Process Operation and Equipment Problem Solving &Troubleshooting (Mar'19)
84) GE02: Advanced Process Engineering & Problem Solving Using Excel Spreadsheets & Solvers (Apr'19, PTTGC)
85) PE07: Advanced Principles of Process Design and Basic Engineering of Process Plants (Apr'19, Asia iKnowledge in Malaysia)
86) PE04: Principles to Develop PFD, P&ID, and Piping Engineering Specifications (May'19)
87) PE01: Fluid Flow and Hydraulic Analysis for Engineers (May'19)
88) PE01: Fluid Flow and Hydraulic Analysis for Engineers (May'19, Bangchak)
89) Conceptualizing commercial process picture and understand key scale-up parameters from lab research results (May' 19, PTTGC)
90) PE07: Advanced Principles of Process Design and Basic Engineering of Process Plants (Jun'19)
91) PE01: Fluid Flow and Hydraulic Analysis for Engineers (Jun'19, GPSC)
92) PE21: Practical Energy Efficiency Improvement and Optimization for Process Industries (Jun'19, PTTGC)
93) PE21: Practical Energy Efficiency Improvement and Optimization for Process Industries (Jul'19)
94) PE05: Distillation Process & Equipment Design, Sizing, troubleshooting (Jul'19)
95) PE09: Heat Exchanger Design, Specification, Rating and Sizing (Sep'19)
96) GE03: Practical Project Management and Project Engineering Essential Knowledge for Engineers (Sep'19)
97) PE13: Process Equipment and Operation Problem Solving & Troubleshooting (Oct'19)
98) GE03: Practical Project Management and Project Engineering Essential Knowledge for Engineers (Nov'19, BST)
99) PE13: Process Operation and Equipment Problem Solving &Troubleshooting (Oct'19)
100) PE01: Fluid Flow and Hydraulic Analysis for Engineers (Nov'19)
101) PE07: Advanced Principles of Process Design and Basic Engineering of Process Plants (Nov'19)
102) PE23: Scale-Up of Process & Equipment: Batch and Continuous Stirred Tank, Fixed Bed, Trickle-Bed Reactors (Dec'19)
103) PE04: Principles to Develop PFD, P&ID, and Piping Engineering Specifications (Dec'19)
104) PE:09 Heat Exchanger Selection, Design, Specification, Rating and Sizing (Feb' 20)
105) GE01: Capital and Operating Cost Estimation and Project Economics for Engineers (Feb' 20)

106) PE:18 Pressure Relief System Design & Sizing: Safety Valves, Vacuum Relief, Blowdown, Depressuring, Flare (Feb' 20, Syntex Energy)
107) GE03: Practical Project Management and Project Engineering Essential Knowledge for Engineers (Mar' 20)
108) PE10: Pump and Compressor Systems Engineering Design, Specification, Sizing (Mar' 20)
109) PE09A: Shell & Tube and Air-Cooled Heat Exchanger Design, Specification, and Sizing (May' 20, Innovek Asia)
110) GE01: Capital and Operating Cost Estimation and Project Economics for Engineers Online (Jul' 20, KMUTB Rayong)
111) PE10: Pump and Compressor Systems Engineering Design, Specification, Sizing (Augr' 20, Mayekawa)
112) PE10: Pump and Compressor Systems Engineering Design, Specification, Sizing (Aug' 20, Thyssenkrupp)
113) PE09: Heat Exchanger Design, Specification, Rating and Sizing (Sep' 20, Thyssenkrupp)
114) PE13: Process Equipment and Operation Problem Solving & Troubleshooting (Sep'20)
115) GE03: Practical Project Management and Project Engineering Essential Knowledge for Engineers (Sep'20)
116) GC02: Refining and Petrochemical Processes: Essential Knowledge for People in the Chemical Industry (Oct'20, CR Asia)
117) PE21A: Practical Energy Efficiency Improvement and Optimization for Refineries (Oct'20, PTTGC)
118) PE01: Fluid Flow and Hydraulic Analysis for Engineers (Oct'20)
119) PE07: Advanced Principles of Process Design and Basic Engineering of Process Plants (Nov'20)
120) OP01: Understanding Process Equipment for Better Operation and Maintenance (Nov'20, PTTGC)
121) PE09: Heat Exchanger Design, Specification, Rating and Sizing (Dec' 20)
122) PE09: Heat Exchanger Design, Specification, Rating and Sizing (Dec' 20, JPJ Industrial Services)
123) PE04: Principles to Develop PFD, P&ID, and Piping Engineering Specifications (Dec'20)

Technical Publication List

1) Wiroon T. et. al., "Design of Mixing in Microfluidic Slugs based on a New Dimensionless Number for Precise Mixing and Reaction Operations," 2006, Chem. Eng. Sci., Vol. 61 Issue 13, 4220-4232
2) Wiroon T. et. al., "Design of Microfluidic Liquid Slug Mixing based on a Dimensionless Mixing Rate and a Modified Peclet Number," 2006, Chem. Eng. Sci., Vol. 61 Issue, Vol. 61 Issue 22, 7386-7392
3) Matsuyama K., Wiroon T., et. al., "Operation of Microfluidic liquid slug formation and slug design for kinetics measurement," 2007, Chem. Eng. Sci., Vol. 62 Issue 18-20, 5133-5136
4) Wiroon T., "Saving Energy in Multi-Level Steam Systems", Jan 2012, AIChE Chemical Engineering Progress (CEP) magazine
5) Kongkiat S., Wiroon T. et. al., One patent granted in China, ZL 2009801631658 PROCESS FOR REDUCING THE BROMINE INDEX OF A HYDROCARBON, published date: December 24, 2014
6) Wiroon T., "Accelerating Process and Product Development", Feb 2013, Chemical Engineering (ChE) magazine (US)
7) Wiroon T., Grittaya S., "Unlocking the Secrets of Plate-and-Frame Heat Exchangers", May 2014, Chemical Engineering (ChE) magazine (US)
8) Wiroon T. et al., "Analysis and Optimization of High-Emissivity Coil Inserts to Improve Overall Coil Heat Transfer at Lower Pressure Drop and Shorter Residence Time in Ethylene Furnaces", submitted paper orally presented in AIChE 2015 Spring Meeting, 27th Ethylene Producers' Conference.
9) Wiroon T., Kongkiat S., "Solve On-line Analyzer Time Delays by Improving Sampling System Design", Jan 2016, Hydrocarbon Processing Magazine (US).
10) Wiroon T., "Study, Research, Work Experiences", SCEJ Magazine Japan, Jan 2017
11) Process for enhanced separation of ethylbenzene, European Patent, WO 2016036392 A1