PE10: Pump and Compressor Systems Engineering Design, Specification, Sizing

Pumps and compressors are the most common equipment for fluid transport in process plants. However, most process engineers understand about pumps and compressors too superficially to perform in-depth calculations and troubleshooting of pump and compressor systems. This course provides essential knowledge on specific requirements for each type of pump & compressor and typical P&ID examples that process engineers should understand. It also covers the basics of shaft sealing, seal flushing systems, series vs. parallel operations, variable speed driver effects, viscosity corrections for centrifugal pumps. It also explains the difference between compressors and blowers (or fans), so that engineers can calculate suction and discharge conditions correctly.

Target Group: Engineers e.g., chemical engineers and mechanical engineers, process design engineers, process engineers, engineering company engineers, any technical personnel dealing with pumps and compressors in terms of design and engineering, specification, and troubleshooting of pump & compressor systems

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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. Pumps

A. Pump types and selection: centrifugal vs. positive displacement

B. Design and Process Requirements

- Flow rate, differential head, discharge pressure, max suction pressure, max shut-off pressure, design pressure setting
- Mechanical design temperature
- Net Positive Suction Head (NPSH)-available

12:00 PM – 13:00 PM Lunch Break

13:00 PM – 17:00 PM

I. Pumps

C. Centrifugal Pumps

- Pump performance curve
- Series vs. Parallel operations
- Capacity control methods
- Efficiency, motor driver power

- Driver sizing and standard motor rating
- Suction specific speed, NPSH-required
- Adjusting pump performance by affinity laws
- Temperature rises due to pumping
- Power reduction: variable speed vs. constant speed control
- Viscosity correction for centrifugal pumps

D. Reciprocating Pumps
- Pump performance curve
- Capacity control
- Motor driver power estimation
- Suction line arrangements
- Pulsation suppression devices
- Relief valve, back pressure regulator

E. Rotary pumps
- Type selection, pump performance curve, flow pulsation

F. Pump P&ID Preparations
- Centrifugal pumps
  - Specific requirements and typical P&ID examples: operating conditions & temp, fluid properties, auto-start, etc.
- Reciprocating and rotary pumps
  - Specific requirements and typical P&ID examples: pulsation suppression, pressure relief, etc.

G. Shaft sealing basics: mechanical seal types, selection, concepts, seal flushing systems

Day 2:

8:00 AM – 9:00 AM Register

9:00 AM – 12:00 PM

II. Compressors

A. Compressor types and selection: centrifugal vs. positive displacement

B. Design and Process Requirements
- Flow rate, polytropic head, discharge pressure, suction pressure, design pressure setting
- Settling-out pressure for compressors with recycle or closed loop
- Mechanical design temperature
- Polytropic vs. Isentropic calculations

C. Centrifugal Compressors
- Compressor performance curve
- Surge and anti-surge control scheme
- Capacity control methods
- Number of compression stages
- Polytropic efficiency, brake horsepower
- Driver sizing and standard motor rating
- Affinity Laws

D. Reciprocating Compressors
- Compressor performance curve
- Capacity control methods
- Clearance pocket calculations
- Number of compression stages
- Horsepower loading characteristics
- Pulsation suppression, relief valve

12:00 PM – 13:00 PM Lunch Break

13:00 PM – 17:00 PM

II. Compressors

E. Blowers and Fans
- Types and selection
- Determination of suction and discharge conditions
- Fan laws

F. Compressor P&ID Preparations
- Supplementary equipment
  - Compressor suction drum, interstage knock-out drum, interstage cooler, spillback cooler
- Instrumentation: suction and discharge
- Safeguarding systems: alarm, ESD, safety relief valve, etc.
- Centrifugal compressors
  - Specific requirements and typical P&ID examples
- Reciprocating compressors
  - Specific requirements and typical P&ID examples: pulsation suppression, pressure relief, etc.

G. Shaft sealing basics

H. Lube oil, seal oil, gas seal basics

III. Calculation examples
- A vessel bottom pump system transferring liquid to a storage tank
- A multi-stage compressor system with suction drums and inter-stage coolers

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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