PE09: Shell-and Tube Heat Exchanger Design, Specification, and Sizing

Shell-and-tube heat exchangers are widely used in process industries due to its robustness and well-established design methods. Process engineers often have to specify shell-and-tube heat exchangers and perform calculations to confirm heat exchanger sizing and sufficiency of heat transfer area. Lack of understanding results in wrong equipment selection and specifications, inability to achieve desired process performance, and even safety issues in operation.

**Target Group**: All disciplines of engineers and any technical people who have to design, specify, and operate shell-and-tube heat exchangers for chemical processes

**Course Outline:**

1. **Heat Transfer Basic Concepts**

* Heat transfer mechanism and basic equations
* Convection
* Conduction
* Radiation
* Heat exchanger flow principles: laminar vs. turbulent
* Heat balance for no-phase change and phase change heat exchangers
* Heat transferability diagram developed by Ajarn Charles: Easily understand what parameters determine which types of heat transfer are difficult or easy

1. **Shell-and-Tube Heat Exchanger Types and Selection**

* Advantages and disadvantages
* TEMA types: fixed tube sheet, floating head, U-tube, kettle type
* Fixed tube sheet, floating head, U-tube, kettle type

1. **Heat Exchanger Design and Sizing**

* Overall heat transfer coefficients (U)
* Tube-side heat transfer coefficients
* Tube-side pressure drop
* Temperature profile for all cases of heat transfer
* Log-Mean Temperature Difference (LMTD) assumptions
* Temperature crossover and F-Factor to Correct LMTD to MTD (effective mean temperature difference)
* Heat transfer area calculations
* Fouling factors
* 3 major sizing methods for shell-side heat transfer coefficients and pressure drop
* Kern method
* Bell-Delaware method
* Flow stream analysis method (Willis-Johnston)
* Resistance analysis for heat exchanger enhancements and improvements
* Optimum temperature difference for design
* Pressure drop guidelines
* Phase-change heat exchanger design principles
* Condensers
* Reboiler types and configurations

1. **Heat Exchanger Specifications**

* Design pressure and temperature setting: 10/13 rule, 2/3 rule
* TEMA shell, shell head, channel head types and selection
* Tube bundles
* Tube layout and tube pitch
* Baffle types and selection
* Standard tube length
* Shell diameter and number of tubes

1. **Example Problems on Shell-and-Tube Heat Exchanger Sizing**

* Condenser basic sizing
* Reboiler basic sizing
* No-phase change heat exchanger basic sizing
* Kern method and Bell-Delaware methods

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**Your Instructor:**

Mr. Wiroon Tanthapanichakoon, Senior licensed chemical engineer in Thailand, license no. สค 155

**Qualifications:**

* Technology Director and Technical Advisory Board Member of Global R&D Co. Ltd.
* 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)
* Invited lecturers and instructors for various technical seminars such as 1) a senior-year process plant design course (Naresuan Univ.); 2) a graduate school course on chemical process scale-up and scale-up of catalytic fixed-bed reactors (Chulalongkorn Univ.); 3) a public seminar on fixed bed reactor scale-up; 4) a lecture on Industrial Viewpoint on Process Innovation and Process Engineering (King Mongkut Institute of Technology, Ladkrabang. KMITL); 5) Company internal training on Fluid Flow & Hydraulic Analysis, Mass Transfer Equipment Design and Scale-Up, Fixed-Bed Reactor Design and Scale-Up; 6) a special seminar on scale-up in chemical engineering (VISTEC, มหาวิทยาลัยปตท.); 7) a public training on Technical Writing & Presentation for Professionals (Thai-Nich Technology Promotion Association, ส.ส.ท.); 8) Invited lecturer on “Use of Thermodynamic Knowledge in Reaction Scale-Up” and “Excel Spreadsheet Skills for Practicing Chemical Engineers (KMUTNB, มจพ. ระยอง)”
* 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