ChE **book review**

Elementary Principles of Chemical Processes

3rd Edition

By *Richard M. Felder and Ronald W. Rousseau*

John Wiley & Sons, 605 Third Avenue, New York, NY 10158-0012; 675+ pages; $111.95 (cloth); (2000)

Reviewed by
D. Hunkeler
Swiss Federal Institute of Technology

The third edition of this classic introductory chemical engineering text is intended to compliment a first course in stoichiometry, material and energy balances, and introductory thermodynamics. As such, it is aimed at engineering and chemistry students who have completed their first year of general university education. Freshman physics and chemistry are valid prerequisites, although if the course is taught with the complimentary teaching modules, one could consider offering it earlier. The third edition follows the same format as the previous two editions, with a preliminary set of three chapters discussing the units and dimensioning of process variables and their associated calculations. This section is (in some curricula) omitted, due to its coverage in other courses, but it is a valuable asset since many student difficulties in balances occur due to sloppy "accounting."

The body of the text discusses material balances, first for non-reactive single-phase processes and then adding multiphase systems, recycling, and bypass. One of the strengths of the book is the ease with which the authors' introduce thermodynamics into the subject matter. Equations of state for non-ideal gases, compressibility, multicomponent equilibrium, and two-phase partitioning and solid-liquid-vapor phase diagrams are presented in a comprehensible manner that permits students to begin solving problems on the day of the lecture. This is something Felder has long advocated in his interactive teaching approaches, and the third edition certainly shows the value of the NSF's sponsoring of the concepts which brought it to fruition.

The text also integrates graphical presentations of correlations with computer-based programming challenges. The students will not realize until subsequent courses, to what extent they have been introduced to (and to a large extent mastered) elementary chemical and engineering thermodynamics. The problems at the end of the chapter do an excellent job of integrating the concepts presented, along with statistics, into the estimation of thermodynamic data.

Practical problems, related to a series of important unit operations including various separation methods such as absorption, adsorption, condensation, crystallization, distillation, and extraction are presented throughout the first eleven chapters. The authors' also discuss batch, semi-batch, and continuous reactors operating under adiabatic and isothermal conditions, both at steady state and dynamically. Combustion is treated separately. Liquid-gas processes including evaporation-compression, humidification, dehumidification, and scrubbing are also integrated into material and energy balances. Overall, the new problems are challenging, yet doable.

The third section of the book discusses energy and energy balances. There is minimal overlap with the discussion of forms of energy typically presented in freshman physics. Energy balances on non-reactive processes challenge students to organize their solutions. The text pulls itself together in Chapter 9 when the enthalpy of reaction is used, and estimated, principally to permit the calculation of a reactor's energy loss, temperature, or pressure. The balances are also extended to complete processes. Discussions of alternative fuels, which may appear old-fashioned, is a take-home deliverable from this text, as are its extensive data base (tables, graphs, and CDs) that may convince sophomores they never have to set foot in an engineering library.

The text concludes with a chapter on computer-aided calculations, which many schools cover in a separate course (as they do the material on transient processes). But if Chapters 10 and 11 are omitted, Chapters 12 through 14 cannot be. The authors' offer three case studies (one in the area of materials and two in commodity chemistry) that need to be presented at the end of the two-semester sequence to convince students they can, indeed, design plants. It is a motivation which will drive many of them to integrate kinetics, reactor design, transport phenomena, and separations into their working knowledge and become chemical engineers. As the only chemical engineering course taught to chemists, in my experience, it provides an excellent sensitization to the challenges facing industrial organic and polymer chemists when they develop new (macro) molecules.

The text comes with a CD that includes an animated encyclopedia of chemical process equipment, the E-Z solve software for balances along with tutorials, and an index of learning styles. As fantastic as these are, the real value is that the physical property database demystifies the coupling between thermodynamics and engineering, which confuses so many students. With the database provided, carrying out material balances is no longer a cumbersome task akin to financial accounting, but is fun. Felder and Rousseau have made chemical engineering enjoyable. My students make significantly less calculation errors on their balances thanks to the third edition of this book, and they are motivated and listen better to the concepts their predecessors had ignored.

Overall, the authors' present a way for introductory students to respect complexity and understand the need for engineering approximations. Take the authors' advice to let the students enjoy problem-based learning—they will better understand themselves, their career, and their choices. The book is a service to our profession. ❐