Transport Phenomena Fundamentals

By Joel Plasky, CRC Press, 2nd ed. 2010. 833 pp., $129.95

This text is designed for an undergraduate chemical engineering two-term sequence in transport phenomena. The author's characterization of transport phenomena as one of the foundations of chemical engineering, along with thermodynamics and chemical kinetics, is well supported by the applications and examples presented throughout. As in the well-regarded first edition, real effort has been made to include applications in biology, biochemistry, and nanotechnology throughout, in particular to the areas of electromagnetism, charge transport, and photonic processes. Although some minor changes to the previous edition have been made, a significant improvement is the use of numerical solution software in the form of examples and homework problems throughout, with example modules included with each chapter. The modules, employing Comsol Multiphysics software, are located online at an accompanying website. This is an outstanding feature, as the chosen software package is specifically designed for standard transport phenomena problems. As the author claims, the software should allow students to address more realistic and relevant problems, as well as to compare results from simplified mathematical approaches to more detailed solutions.

As in the first edition, the organization of the text varies from that used in many of the contemporary texts in the subject. The traditional topics of heat, mass, and momentum transport are integrated throughout. The resulting unified treatment, based on a balance equation approach, begins with steady-state diffusive transport alone, and builds in complexity by considering the additional factors of secondary fluxes, material properties, generation, coupled transport, and accumulation.

There is a good attempt in this beginning section to provide a linkage to equilibrium thermodynamics, but an opportunity is missed in not providing some treatment to nonequilibrium stationary states, so that some understanding of the effect of biologically important selective membrane transport processes such as osmosis and ultrafiltration could be accomplished. Transport through heterogeneous media is considered for energy transport, but not for mass transport.

The second part of the text broadens the treatment to convective transport and the development of the classical microscopic and macroscopic balances, and uses a boundary-layer approach to develop understanding of the transport coefficients. It is overall well done, although treatment of the important chemical engineering subjects of flow of non-Newtonian fluids, multicomponent diffusion, and macroscopic energy balances for reacting flow systems is either minimal or absent.

A chapter on radiative transport concludes. Four appendices on Vector Mathematics, Mathematical Functions Tables and Charts, Exact Solutions to Boundary Layer Equations, and Thermal and Transport Properties of Materials are well presented and should increase the reference value of the text.

Users familiar with pre-existing textbooks and approaches to the subject, as well as students, may find the Index of the text very challenging. In the opinion of the reviewer, it is inconsistent in its treatment of minor and major subjects, and could benefit from significant reorganization, as well as the inclusion of terms such as Nusselt, Hagen-Poiseuille, and Stokes.

Minor shortcomings aside, this is an excellent high-quality and relatively high-level text that should be a valuable reference for students entering the profession, and should provide the basis for excellent courses in the subject. Its major strengths of providing a sound pedagogical integrated approach and its use of user-friendly numerical methods to support the understanding of how chemical engineers approach and solve transport problems in a range of modern applications make it an excellent investment and a valuable teaching tool.

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