Chemical Process Structures and Information Flows

By Richard S. H. Mah, Butterworth, 1990, 500 pp.

One of the hallmarks which has long characterized chemical engineering, in addition to interphase mass transfer and reaction engineering, has been the discipline's embrace of the systems approach. This is perhaps most obvious in the widespread application of computer simulation of entire process flowsheets as a complete interacting system in design, optimization, operations, and control.

Chemical Process Structures and Information Flows is a somewhat specialized book which traces the author's 20-year principal interests in both teaching and research. The topics at first may appear to be almost random: design of pipeline networks, flowsheet simulation calculation sequencing, sparse matrix manipulation, batch process design and scheduling, and plant data observability, redundancy, reconciliation, and rectification. But, of course, there is a theme which is the understanding and exploitation of the systems structure which underlies these and other aspects of chemical process engineering.

The book begins with the design and analysis of pipeline networks, which obviously closely parallel the graphical constructs on which much systems engineering is understood. This leads more naturally to unit operations networks that make up chemical processes and the systems issues involved in implementing flowsheet simulation, particularly using the sequential modular approach. The alternative equation-oriented simulation approach leads to a digression on sparse matrix computation techniques.

The design and scheduling of batch processing plants (actually, covered in reverse order) are again considered from the point of view of the underlying information relationships among materials, flows, pieces of equipment, and time. And, finally similar information relationships have enabled the more recent understanding of process variable observability and redundance, and of process data reconciliation and error rectification.

Both the text and problems are largely theoretical. For instruction, this book is probably best suited to a specialized graduate-level course, although advanced undergraduates with a good foundation in linear algebra would have little difficulty. Graph theoretic concepts, which pervade all of the book, are covered in an introductory chapter, and sufficient probability and statistics to follow data reconciliation material are included in an appendix.

Practicing engineers might at first be distressed, because there are few practical examples or applications, and one would be hard pressed to design or schedule a batch operation straight from reading the text. Furthermore, few engineers are involved in pipeline network design, and even fewer worry about calculation ordering or the sparse manipulations within their commercial simulation packages. But, that would be to miss the point. There is indeed much to be learned and appreciated from a better understanding of systems concepts and a historical tour through the role they played in the development of the methods buried within our everyday computational engineering tools. And for that reason, this book is recommended.

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Elementary Fluid Mechanics

By D. J. Acheson, Oxford University Press, 1990, 397 pp.

This book deals with the *physics* of fluid dynamics. It is not a dreary recital of mathematical methods and tedious theorems. It gives a concise, general introductory overview of the subject. Vector calculus and differential equations are used, but the mathematics is subservient to the physics.

The author is clearly enthusiastic about the subject, and the reader cannot help but feel the excitement. Frequent citations from the famous seminal papers give a sense of the rich history of fluid dynamics as well as an appreciation for the real, live people who made the discoveries and advances. Citations to the recent literature make the reader aware of the current directions of the field.

The author has adopted an interesting and pedagogically sensible approach. Chapter 1 introduces ideal fluids and some important concepts and definitions. Chapter 2 gives a simplified discussion of viscous fluids along with the solutions to a number of elementary problems and a qualitative discussion of more complicated ones.

Chapters 3 (Waves), 4 (Airfoil Theory), and 5 (Vortex Motion) are based on the ideal fluid, but, because of the intervening chapter on viscous fluids, the restrictions of the applicability of ideal fluid theory can be discussed meaningfully. The chapter on waves includes water waves, sound waves, capillary waves, shock waves, and solitary waves. The airfoil discussion is centered mainly on problems that can be done by conformal mapping. The vortex chapter includes some of the famous theorems from classical hydrodynamics, as well as a variety of topics, including lift generation in hovering insects, behavior of tornadoes, circulation in teacups, the vortex ring generator, and the von Kármán vortex street.

Chapter 6 returns to viscous fluids with the linear-law expression for the stress tensor, the Navier-Stokes equations, and the rate-of-deformation tensor. Chapter 7 deals with creeping flow, including lubrication theory, low Reynolds number swimming, and a concise summary of the Proudman-Pearson extension of the problem of Stokes flow around a sphere.

Chapter 8 on boundary layers is very adroitly handled, with a lucid explanation of the matching of inner and outer solutions. Converging channels, Ekman boundary layers, and unsteady spindown are used as illustrations. The book concludes with Chapter 9 dealing with instability, linear stability theory, period doubling, and chaos. Unfortunately, there is no chapter on turbulence; this reviewer hopes that one will be added in the second edition.

Each chapter contains a set of problems; hints and answers are provided at the end of the book. An appendix giving vector identities, integral theorems, and operations in curvilinear coordinates is included.

This reviewer was glad to see the "real" operator sign used at the top of p. 53; beginners are often confused when this is omitted. The careful distinction between fixed volume elements and material volume elements ("dyed material") is to be applauded. In Problem 1.4 on p. 24 it would have been better to use the term "mechanical energy equation" rather than the "energy equation," the latter term perhaps implying a "total energy equation." This reviewer prefers to think of the "Reynolds transport theo-