polymer-solvent compatibility were individually adjusted. In addition, the effect of the rate of cooling following annealing (baking) was carefully examined. The analysis was based on the varying free volume fraction trapped in the glassy film upon cooling. Effects of physical aging below glass transition were also included. An ongoing experimental and theoretical project originated out of this effort. Non-isothermal polymerization in tubular reactors and CSTR's in series, rheology of fiber suspensions in polymeric matrices, and transient temperature profiles of local spots irradiated with laser pulses were additional examples, which led to certain past as well as current research activities.

Besides maturing into full-fledged research projects, major results of previous class efforts were disseminated in later offerings. Some problem statements were modified so that current students could build upon earlier findings and study unexplored features. Hence, although successive classes were handed revised sets of problems, the basic theme remained the same. One thing is certain. The course in polymer processing at Berkeley continues to evolve and yet remains a rewarding experience for the instructor.

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REVIEW: Liquid Filtration

cludes examining them in more detail by referring to the original work.

After reading the book and observing the number of papers that have been written, it appears that a coherent filtration theory that connects the very practical aspects of filter media selection, predictive rather than reproductive filter

design, and optimal operation has eluded this significant research effort on a unit operation that is common to a wide segment of the chemical process industries. □

ChE book reviews

MOMENTUM, HEAT, AND MASS TRANSFER
by C. O. Bennett and J. E. Myers
Third Edition, McGraw Hill, Inc. (1982), pp. 832

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How should transfer operations be taught? The answer to this question determines the choice of textbooks for such a course. The unit operations approach was effectively advocated in a number of textbooks which appeared in the 1950s. This was in line with the earlier evolution of the subject area. The development of a unified transport theory profoundly affected the teaching of transport phenomena at the graduate level and also led to a critical evaluation of how transfer operations were being taught to undergraduates. As a consequence, textbooks emphasizing the fundamentals and providing a connection between transport theory and unit operations were conceived. One of the prominent outcomes was *Momentum, Heat, and Mass Transfer* by Bennett and Myers, first published in 1962.

The publication of the Third Edition of *Momentum, Heat, and Mass Transfer* is a measure of the favorable reception the book has received, since its first appearance, for its approach to teaching transport processes. The Third Edition of the book is essentially identical to the Second Edition. The principal change is the introduction of SI units in a larger number of problems. Further, in each chapter, two or three additional exercise problems have been introduced. However, the added problems are similar to those already existing and they provide an instructor with a larger quantity rather than a larger variety of problems to choose from.

Momentum, Heat, and Mass Transfer by Bennett and Myers is written primarily as a textbook. The material is arranged in three main sections dealing with the three transfer operations. The early chapters in each section deal with fundamental transport theory. Each section includes a discussion of relevant design equations

arguments play a key role. The calculations are simplified using the rotational transformation properties of tensors.

The second volume discusses applications, including the thermodynamics of mixtures, surface properties, dielectric properties, and spectroscopic properties. These two volumes provide a comprehensive description of the types of theories of equilibrium fluids which eventually will become dominant in chemical engineering practice. □

REVIEW: Momentum, Heat, Mass

and considers the unit operations as applications. Under fluid dynamics various concepts are first introduced, including a brief presentation on rheological models. In the next three chapters the conservation of mass, energy and momentum principles are formulated for a macroscopic control volume. An immediate application is provided by techniques for flow measurements in Chapter 6. The differential mass, energy and momentum balance equations are then derived and some examples showing the use of Navier-Stokes equations are presented. Chapters 11 and 12 deal with boundary layer flow and turbulent flow. The complexities in their analytical treatment lead into the approach of dimensional analysis in Chapter 13. The design equations are presented in terms of non-dimensional groups for flow in closed conduits and for flow around solid objects in Chapter 14. The section closes with a discussion of filtration as a unit operation. The emphasis throughout is on incompressible fluids.

The section on heat transfer starts by introducing the various mechanisms of heat transmission. Steady and unsteady state heat conduction are then discussed and the student is introduced briefly to the role of numerical, graphical and analog techniques for solving conduction heat transfer problems. The convection heat transfer under laminar and turbulent flow conditions is considered in Chapters 22 and 23, followed by a review of correlations in terms of dimensionless groups for the convective heat transfer coefficients. Heat transfer accompanied by phase change during boiling and condensation is considered in a separate chapter. Chapter 26 provides a concise introduction to the radiant mode of heat transfer. The application of heat transport theory to the design of heat exchange equipment concludes the section on heat transfer.

The last section on mass transfer follows along similar lines. The section begins with an introduction to molecular diffusion and diffusivity. Molecular diffusion in binary mixtures is then described. Convective mass transfer under laminar and turbulent flow conditions is considered in Chapters 32 and 33. Relevant design equations for mass transfer coefficients are detailed in the following three chapters. The remaining six chapters are devoted to mass transfer operations. They are organized as follows: continuous contacting of immiscible phases; simultaneous mass, momentum and energy transfer; equilibrium stage separations; contacting of partially miscible phases; distillation of binary mixtures; and multicomponent separations.

The material is organized in all three sections in such a way as to make the connection between transport theory and unit operations more visible. This connection is demonstrated with different degrees of success in fluid dynamics, heat transfer and mass transfer. The emphasis of a first course in transfer operations is on the macroscopic approach. At the same time, it is desirable to introduce the student (at least in a limited way) to the differential approach. Such a goal is achieved by this book. The solutions to various problems require the use of a variety of correlations. The separate chapter on dimensional analysis and the chapters on design equations in each of the three sections allow the student to appreciate how the correlations are developed on a rational basis and how they can be meaningfully used. Since the aim of the book is to expose the student to transport theory and to present the three transfer operations in a unified way, the book had to limit the extent of details presented on various unit operations, particularly in mass transfer. I do not consider this to be a disadvantage because this is a conscious choice an instructor has to make if he or she subscribes to the outlook of this book.

From the point of view of students, I would have liked to see some "real" changes in the Third Edition, especially relating to example and exercise problems. First, the number of example problems solved in the text should have been increased. This is especially needed for the chapters on differential balances. While the rheological models are briefly introduced in Chapter 2, their integration into the equation of motion is not

adequately illustrated through examples. The number, and more importantly the variety, of exercise problems in many chapters should have been increased. Use of experimental data as the basis for problem formulation is rarely attempted in the book. A refreshing exception is provided by the example problem under dimensional analysis dealing with the formation of bubbles of one phase in another. I also wish that the problem statements were more interesting than they presently are throughout the book in order to capture the students' interest. One would have expected to see in the Third Edition examples and problems illustrating the application of transport theory to modern chemical engineering problems —those that have become important in the years since the Second Edition of the book.

Overall, *Momentum, Heat, and Mass Transfer* by Bennett and Myers has firmly established itself as a textbook for those choosing to study unit operations guided by transport theory. While one or another feature of the book may be found less than satisfactory by different instructors, they could easily be improved by the use of supplementary material prepared by instructors. Until a more appealing approach to teaching transfer operations emerges, the book by Bennett and Myers will remain prominently in many students' bookshelves. □

CORROSION ENGINEERING

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GENERIC QUIZ

- I think the only thing about it that makes me feel uncomfortable is the grading. While in some cases it may be pretty obvious the person didn't work hard it seems to me that in others a person might come up with a good comprehensive test, but just not be in the type of format the grader may be looking for. This feeling would be hard to verify, though.
- If it had a drawback it was in the time required to do a decent job. Clearly, this was an assignment which could absorb as much time as one was willing to give to it.
- I think it is very difficult to be creative and yet produce reasonable questions. This made the exercise somewhat frustrating and time consuming.
- Nothing. I couldn't wait to work on it.

Things gained from the experience

Students also volunteered comments on what they had gained from the experience. Many repeated points they made in the "Things liked" category regarding the depth of study required to make up a good examination. One comment I