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## REVIEW: Process Fluid Mechanics

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would have been to present a detailed presentation of a few important design correlations. A more complete treatment of the application of the mechanical energy balance to non-isothermal and compressible systems is needed.

In the third section the development of differential balances of mass and linear momentum is given, with the same clarity and in the same notation as the macroscopic balances of the preceding section. The presentation of the Cauchy and Navier-Stokes equations is made in tensor notation. I have not found this to be an impediment to students' understanding. To the contrary, the dimensional relationship between vectors and tensors provides a clear distinction between force and stress. Students in my classes are very willing to learn new mathematics when they believe it is motivated by a need to frame an otherwise difficult concept and not by a pretense of rigor. The following chapter applies these conservation equations to the usual one dimensional flows.

The next section of the text is a skillful arrangement of topics in which creeping and inviscid flow limits are taken on the Navier-Stokes equation in reduced form. These limits are first introduced in a separate chapter on Hamel flow which is an excellent choice of problems, since numerical solutions can be obtained easily and compared to the limiting analytic solutions. This gives me a chance to reiterate the importance of the reduction of complex problems to underlying primitives and to make the connection between this reduction and the limiting process.

The final section is composed of a series of "special topics," which includes chapters on turbulence and viscoelasticity. Much of the background for a discussion of turbulence is provided in the preceding chapters on inviscid and boundary layer flow and the emphasis here is on the time averaging of the Navier-Stokes equation and the development of the universal velocity distribution. I believe that a brief introduction to stochastic processes is more useful to the student at this point than the following chapter on numerical solutions of PDEs. This allows for some continuity in the introduction of viscoelastic behavior as "fluid with memory." Missing from the chapters on viscoelastic and turbulent flows are the "gee-whiz" phenomenon which leave the student at the end of the semester with a taste for the variety of scientific experience and provide the qualitative extension to complex systems which had, otherwise, been the consistent theme of the text. □

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## ENGINEERING FLOW AND HEAT EXCHANGE

*by Octave Levenspiel*
*Plenum Press, New York, NY 10013 (1984)*
*366 pages, $34.50*

**Reviewed by**
**Roland A. Mischke**
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This book presents the basic macroscopic equations for the solution of fluid flow and heat transfer problems in concise form. However, the major thrust of the book is in the application of these fundamental equations to the solution of problems not usually encountered in typical courses in fluid flow and heat transfer (particularly those dealing with particulate systems).

On paging through the book, one is first struck by the freehand illustrations (did a human being write this book rather than a computer?) and fluid flow problems with such intriguing titles as "Counting Canaries Italian Style." I have often thought of Octave Levenspiel as the Dr. Seuss of chemical enginering—an author who uses the premise that even the learning of engineering principles can be fun. Just as Dr. Seuss introduced us to the alphabet beyond the letter "z" in "On Beyond Zebra," so Octave Levenspiel might well have titled this work "On Beyond Transport Phenomena."

The book is divided almost equally between the two areas, and the fluids portion successively treats: Basic Equations for Flowing Streams, Flow of Incom-

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membrane counterparts. Better cell and virus growth was obtained with the former capsules. This was possibly due to the lower intracapsular alginate content. High virus concentration ($9 \times 10^8$ IFU/mL) were obtained with these microcapsules.

The growth of temperature-sensitive baculoviruses inside microcapsules appears to be a novel development. The ability to turn viral replication on by simply lowering the culture temperature has allowed, for the first time, the growth and concentration of virus inside of cell-filled microcapsules. Work is continuing on the production of recombinant proteins by encapsulated infected insect cells in an external-loop air-lift bioreactor.


## ACKNOWLEDGEMENTS

The encapsulated cell culture studies were performed by Mr. Glenn King. The insect cell baculovirus work is being done in collaboration with Dr. Peter Faulkner. The bioreactor expertise was provided by Dr. Andrew J. Daugulis. This work was supported by a Strategic Grant from the Natural Sciences and Engineering Research Council of Canada.


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## REVIEW: Levenspiel

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pressible Newtonians in Pipes, Compressible Flow of Gases, Molecular Flow, Non-Newtonian Fluids, Flow Through Packed Beds, Flow in Fluidized Beds, and Solid Particles Falling Through Fluids. The heat transfer section covers: The Three Mechanisms of Heat Transfer, Combination of Heat Transfer Resistances, Unsteady-State Heating and Cooling of Solid Objects, Introduction to Heat Exchangers, Recuperators, Direct-Contact Gas-Solid Nonstoring Exchangers, and Heat Regenerators. The book ends with a chapter called Potpourri of Problems.

The preface to the book indicates it is not for beginners. Levenspiel carefully states that the book is meant for practicing engineers and for those who have had an introductory course in transport phenomena. In keeping with that statement, the first paragraph of the text starts out with the First Law of Thermodynamics; the Second Law is covered in the second paragraph. This is definitely not a place for the raw beginner. Levenspiel quickly develops the macro-

scopic equations and then moves into applications of the whimsical, thought-provoking type for which he is famous.

While reviewing the book I got the feeling that Levenspiel is trying to fill a void in modern engineering education. Here is a book devoid of partial differential equations (except for the unavoidable ones in unsteady heat transfer), vector notation, numerical methods and computer-based problems. This is a book that tries to keep thinking from becoming a lost art. Levenspiel has cleverly used his whimsical problems to encourage new thinking and application. By moving the reader away from standard CPI applications, creativity and thinking are encouraged because these are not the "real" problems facing an engineer. In fantasy land one is not constrained by past experiences, so imagination can have free rein. Almost unknowingly one takes his fundamental models of the universe and applies them to the new situation.

I found the heat transfer part of the book less satisfying than the fluid flow part. The second half of the book is much more a recital of equations. There are chapters with no examples or problems at the end of the chapter. The clever application problems drop from about 50% in the fluids portion down to about 25% in the latter portion. One almost gets the impression that the author was running out of steam during the last part of the book.

Chapter 16 is a refreshing assembly of problems with no tie to any previous chapters. In an era where many textbooks almost tell you what equation in a given chapter applies to a particular problem, Levenspiel gives some multi-concept problems and leaves the rest to the reader. Bravo!

The book uses SI units exclusively. I would rather see a mixture of applications using English units, particularly if the audience is to include practicing engineers. Engineers still must be comfortable with more than one system of units.

There are no answers provided for any of the problems. For a clientele of practicing engineers who want to check their understanding of what they are learning, answers to some of the problems would help.

It may prove unfortunate that the book will not really find a home. With the structured and crowded curricula which are now so common, it may not be readily usable. It is definitely not a teaching text in the usual sense—there are too many gaps for a new learner to bridge. Perhaps it may serve as an adjunct text in a design course. If such is the case, then a less expensive paperback edition would make it more attractive. In any case, finding a home within the university for this book may well require some creativity on the part of the professor (the author has already done his part). □

## ChE letters

### SAFETY MODULES AVAILABLE

Dear Editor:

I read with considerable interest the article in the spring 1988 issue, "Safety and Loss Prevention in the Undergraduate Curriculum: A Dual Perspective," by Dan Crowl and Joe Louvar. As one of the founders of AIChE's Center for Chemical Process Safety and as a promoter, while AIChE Executive Director, of increased emphasis on safety in the undergraduate curriculum, I commend Wayne State and BASF for their video training sessions.

In their article, Crowl and Louvar note the "ambitious safety and loss prevention program" in Great Britain. This program, under the leadership of the Institution of Chemical Engineers, has led not only to formal safety instruction in universities, but also to excellent interactive hazard workshop modules. These excellent products are now available in the western hemisphere.

These modules are available in different formats. First, there are seven slide module programs, on subjects ranging from the hazards of plant modifications to human error. In addition, IChemE offers four current videotape and slide programs, on Preventing Emergencies, Inherent Safety (by Trevor Kletz), Safe Handling of LPG, and Safer Piping. Finally, a computer emergency simulation module on Handling Emergencies for IBM and compatible PCs involves the students in a very real simulation of fire or toxic gas release at an operating chemical plant, with actions and results occurring according to the pre-plan assembled by the group. New modules are being prepared on other important process safety subjects.

These modules are ideal for use in the undergraduate curriculum, and are available at special university discount prices. Each package comes with a full text and trainer's guide. I will be pleased to describe and discuss these products with interested chemical engineering academicians.

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