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BOOK REVIEWS

O. E. ROSNER, **Transport Processes in Chemically Reacting Flow Systems.** Butterworths, 1986, xxvii + 540 pp.

THIS BOOK presents a wide-ranging treatise of the concepts and techniques used in chemically reacting flow systems, of engineering interest.

The text was based on the author's teaching of Yale University undergraduate and graduate courses, and was put into its present form with the partial support of EXXON Research and Engineering Co. and Olin Corporation.

The author places the emphasis clearly on generality of principles and on developing the information and skills to formulate and solve engineering problems involving rates of energy, mass and momentum transport in fluids that may be reacting chemically.

The layout in the text is discussed by the author in the Preface of the book, where he provides a particularly useful indication of the topics covered in the various chapters.

The contents are arranged in eight chapters with the following headings:

1. Introduction to Transport Processes in Chemically Reactive Systems.
2. Governing Conservation Principles.
3. Constitutive Laws: The Diffusion Flux Laws and Their Coefficients.
4. Momentum Transport Mechanisms, Rates and Coefficients.
5. Energy Transport Mechanisms, Rates, and Coefficients.
6. Mass Transport Mechanisms, Rates, and Coefficients.
7. Similitude Analysis with Application to Chemically Reactive Systems—Overview of the Role of Experiment and Theory.
8. Problem-solving Techniques, Aids, Philosophy: Forced Convective Heat and Mass Transfer to a Tube in Cross-flow.

Solutions to Selected Exercises and Index.

Each chapter is followed by a Summary, True/False Questions, Exercises, References and Bibliography. The book is well organized for educating students and for reference purposes, and includes excellent exercises, at the end of each chapter, which both illustrate and extend the text. Solutions to some of these exercises are included at the end of the book. Furthermore, Chapter 8 is devoted to a numerical example that is used as a prototype for problem solving. The exercises together with the contents of Chapter 8 constitute, to the present reviewer's opinion, the strong point of this book.

The style of presentation is simple and the text design quality is good, making this book easy to read. It is well printed and illustrated, free of errors, apart from the common nowadays split infinitives, and with no serious misprints. The text layout is of a good standard with clear diagrams and neatly laid out mathematical expressions.

The references include several good texts which provide more details on the relevant topics. A few sections appear to the present reviewer superfluous and should either be extended or omitted in a future edition. For example, appendix 5.1 on Fourier Method of separation of variables and Eigenfunction Expansion is of no use to the reader who is not already familiar with this method, except as a reminder of its existence. The same is more or less true for turbulence modelling, finite-difference, finite-element and method of weighted residuals, topics with ever increasing interest. They should be dealt with in more detail, in a future edition, without unduly expanding the volume of the book. The reviewer appreciated particularly the author's effort to emphasize the use of fundamental laws in the intelligent exploitation of a judicious blend of experiment, analysis, and numerical methods, first to develop the required understanding and then to develop mathematical models for the essential engineering problems involving energy, mass and momentum exchange.

The material is very suitable for teaching courses at various levels, and will appeal to lecturers, students and researchers in science and engineering, who will find a generous stock of material to select to suit their needs. The book should also appeal to any practitioner who wishes to gain further experience of the topic, and develop various levels of problem-solving skills.

In short, I recommend the book to anyone interested in an intelligent technical text on Chemically Reacting Flow Systems. It is a very useful book, providing solid methodology and applications with direct physical background.

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JAMES SUCEC, **Heat Transfer.** Wm. C. Brown, 1985, xvii + 837 pp.

THIS BOOK grew out of the author's experience in teaching a one-semester course in heat transfer to students in an engineering curriculum. It is intended to serve as a thorough text for an engineering course in heat transfer, at the junior or senior level, and to be used as a reference book for practising engineers. According to this reviewer's opinion this purpose has been adequately accomplished in this book.

The well-presented text is divided into nine chapters, as follows:

1. Introduction to Heat Transfer.
2. Steady-state Conduction.
3. Unsteady-state Conduction.
4. Radiation Heat Transfer.
5. Forced-convection Heat Transfer.
6. Free Convection.
7. Heat Transfer in Condensation and Boiling.
8. Heat Exchangers.
9. Additional Topics in Heat Transfer.

Appendices and Index.

Homework problems (both in English Engineering System and SI units) and references follow each chapter.

Chapter 1 discusses the three fundamental modes of heat transfer and the laws governing the energy transfer rates, emphasizing conservation and its importance in solving problems.

Chapter 2 deals with quasi-one-dimensional conduction and develops criteria of acceptance of this approximation. Furthermore, it exposes the boundary conditions, in a very useful way from the teaching point of view. Finally, it discusses two- and three-dimensional conduction, including analytical and numerical solutions.

Chapter 3 contains material on transient conduction including chart and analytical solutions, as well as finite-difference methods. I found Chapters 2 and 3 particularly well documented. Especially, the derivation of finite-difference equations, the development of stability criteria and the need for grid- and time-step independency of the solution are subjects well worth including in a modern text on heat transfer. I would have liked, however, the inclusion of some sample programs to compute for example the temperature distribution for the plane slab solved in Chapter 2.

Chapter 4 is devoted to radiation, including calculation of Net Radiant Loss from Non-gray Surfaces and the Radiation Surface Coefficient of Heat Transfer. The presentation of the contents of this chapter is also very satisfying.

Chapter 5 provides, in a conventional manner, a fluid flow background to forced convection (laminar two-dimensional flow in tubes and ducts, turbulent flow in pipes, external flow over bodies, integral methods, boundary layers) and presents experimental correlations for forced convection through tubes, over flat plates, over cylinders, spheres and tube banks in crossflow.

Chapter 6 deals with natural convection, presenting differential and integral equations and design correlations for vertical plates and cylinders, inclined planes, horizontal cylinders, spheres, and enclosures. The presentation is conventional. Chapter 7 introduces the subject of heat transfer with change of phase (laminar and turbulent film condensation, boiling heat transfer, subcooled nucleate boiling). At the ends of Chapters 5–7 are useful summary tables of the experimental correlations and analytical and semianalytical results for the corresponding heat transfer coefficients.

Chapter 8 introduces the analysis of heat exchangers (parallel-flow, counter-flow and multiple pass heat exchangers, fouling factors, effectiveness method for performance analysis).

The presentation is again conventional.

Chapter 9 is devoted to such special topics as liquid metal heat transfer, transpiration and film cooling and differential similarity. The latter is somehow lost in this chapter and, because of its conceptual and practical importance, it should be brought forward in a future edition, to be used as a prelude to Chapters 5 and 6.

The four appendices are devoted to selected thermophysical properties, emissivities, tables of Bessel and Error functions and to unit conversion factors. A subject index closes the book.

I particularly appreciated the detailed solutions to more than 100 examples in the text and the numerous homework problems that are chosen judiciously to supplement the theory, mathematical methods and experimental information needed to understand the heat transfer phenomena and to solve actual problems. I consider however as a drawback the absence of answers to the homework problems at the end of each chapter. Such answers should be published as a separate volume, in future editions, and will undoubtedly enhance the appeal of the book to both students and lecturers alike.

The text is very well presented with no serious misprints, good layout, clear diagrams, and extremely well laid out mathematical expressions. The references include several good texts which provide more details on the relevant topics, and the sample problems are well thought out and interesting. The general quality of the book is difficult to fault; quality paper, a clear typeface and good binding result in a very attractive book.

It is thoroughly recommended for engineering students and teachers and for the individual scientist and engineer who needs a good reference book.

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R. K. Shah, E. C. Subbarao and R. A. Mashelkar (Editors), **Heat Transfer Equipment Design.** Hemisphere, Washington, DC, 1988, xii+804 pp., £78.50.

This book contains papers presented at the Advanced Study Institute on Heat Transfer Equipment, held in Poona, India, during 16–27 June 1986.

The papers are presented, in a logical manner, in nine sections with the following titles:

1. General review.
2. Mechanical design of exchangers.
3. Fundamentals of single-phase convection as applied to heat exchangers.
4. Thermal design of single-phase exchangers.
5. Fundamentals of two-phase flow heat transfer.
6. Thermal design of two-phase exchangers.
7. Heat transfer augmentation.
8. Fundamentals of rheology and thermal design of heat exchangers for non-Newtonian fluids.
9. Some important operating problems.

This work of over 800 pages with numerous tables, figures and correlations covers the whole field of heat exchanger design, from the basic science to practical aspects. The papers, as it is always the case in this type of Conference Proceedings, are varied both in approach and level of sophistication. It is difficult in one review to do justice to every part of this work, and detailed criticism of each section is better left to users and specialists.

One's first reaction is to be reminded of the vast addition to knowledge of heat and mass transfer, gained in the last few decades. Heat exchangers are required in a wide range of engineering plants and new developments. They were traditionally designed, quite successfully, using only elementary scientific data, but efficiency and performance have since been improved, due to the advances in heat transfer theory and advent of computers. Yet, this book contains only very few examples of the use of computers in heat exchanger design. Indeed, there is only one paper (by D. B. Spalding) that demonstrates the advantages to heat exchanger design of using advanced computational fluid mechanics to predict (rather than guess) the flow field.

This I find a pity for the heat-exchanger-design community, i.e. to rely solely on traditional design methods. Of course it will be a long time before heat exchangers are designed entirely on scientific data, and there will always be an element of art in design based on experience. Yet, there is certainly always scope for innovative and imaginative thought, that can be assisted by more computations.

Section 1 contains a classification of heat transfer equipment, design methodology and effect of uncertainties on the design of systems of heat exchangers. Section 2 presents a review of current codes and standards. Section 3 deals with correlations and Section 4 with the design methodology of heat exchangers (Delaware method, computer programs, synthesis of optimal heat exchanger networks, rotary regenerator design procedures, nuclear heat exchangers, mechanically aided heat exchangers, fluidized bed heat exchangers, waste heat recovery, etc.).

Section 5 is concerned with fundamentals of two-phase heat transfer (boiling in tubes and tube bundles, theory of condensation and in-tube condensation) and is followed by the design considerations, Section 6 (heat pipes, heat pumps, exchangers used in refrigeration systems, reflex condensers, power plant surface condensers, etc.).

Section 7 consists of only two papers on heat transfer augmentation, and the last two sections deal with fundamentals of rheology and thermal design of heat exchangers for non-Newtonian fluids, and operating problems such as flow-induced vibrations and flow instability, respectively.

The book is well set out, well bound and it is easy to find