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BOOK REVIEWS

A. ZUKAUSKAS, **High Performance Single-phase Heat Exchangers** (Edited by J. KARNI). Hemisphere, Washington, DC, 1989.

THIS NEW work by Professor A. Zukauskas was initially published in Russian in 1982. The updated English edition brings to a wider readership what is a distillation of many years work in the U.S.S.R. and particularly in the Institute of Physical and Technical Problems of Energetics, Academy of Sciences of the Lithuanian SSR, on the thermal and hydraulic problems associated with the design of efficient single-phase heat exchangers.

The book as it stands provides a comprehensive source of analytic and experimental data on heat transfer in heat exchanger equipment. It covers a range of flow regimes, in a variety of geometric configurations. Particularly valuable to designers are the sections on heat transfer enhancement techniques and on improving the efficiency of compact tubular heat exchangers.

The subject matter is covered in 22 chapters and 500 pages of text. The layout is good, in that the reader is introduced progressively into the secrets of heat exchanger design, starting from basic principles and definitions and graduating into intricate design details. This makes the book suitable for non-specialists such as advanced students or general consultants. The list of references supplied at the end of each chapter is quite extensive. However, a large proportion of these references comes from Soviet journals which are not published in English. On the subject of language, American English, the translation is good and easily readable.

A brief outline of the book is given below.

- Chapters 1–4 are introductory; definitions, background information, principal thermal–hydraulic equations, physical properties of heat exchanger liquids and modelling basics are given.
- Chapters 5–9 deal with flow and heat transfer in laminar and turbulent boundary layers; effects of acceleration, wall roughness, curvature and freestream turbulence are discussed.
- Chapters 10–14 deal with external flow and heat transfer on tubes and tube bundles, including finned designs.
- Chapter 15 deals with flow induced vibration on tubes.
- Chapters 16 and 17 deal with internal flow in ducts, pipes and annuli; the discussion includes duct cross-sections characteristic of the interstitial space between bundle tubes.
- Chapters 18–20 cover high temperature gas heat transfer including radiation and elementary combustion.
- Chapters 21 and 22 are aimed at the designer, and cover heat transfer augmentation by passive or active means.

Finally I would like to recommend this book to all those involved in the design, research and development of tubular heat exchangers, as a complete and easily readable reference work.

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L.-S. FAN, **Gas–Liquid–Solid Fluidization Engineering**. Butterworths Series in Chemical Engineering, Stoneham, Massachusetts, U.S.A., 1989, XX+763 pp., U.S. $85.00.

TWO-PHASE fluidization can now be considered mature technology, whether the two phases involved are solids and liquid or solids and gas. Liquid–solid fluidization, originally called 'teetering' (i.e. balancing the downward gravitational force of solid particles with the upward drag of an ascending liquid) in mineral dressing circles, has been used for more than a century in the process industries, while gas–solid fluidization, which has become industrially far more important than the liquid–solid mode, has a half century of intense development behind it. Three phase (gas–liquid–solid) fluidization, on the other hand, has been researched seriously only during the past 25 years and, while it has achieved a few industrial successes, is still very much in the process of development, current interest being especially directed toward the burgeoning field of biotechnology (e.g. for a typical aerobic bioreactor, the three phases may be air or oxygen, water or an aqueous solution, and solid particles containing immobilized microbial cells or enzymes).

The behaviour of a three-phase fluidized bed in any of its varieties is in important respects not predictable from the behaviour of any or all of the three two-phase systems composing it. The basic classification of gas–liquid–solid fluidization systems given on page 7 of the present book is therefore crucial to an understanding of the subject. This classification scheme—which distinguishes between expanded bed and transport regimes, cocurrent (upflow vs downflow) and countercurrent flows of gas and liquid, gas-dispersed and liquid-dispersed regimes—provides the organizing principle of the whole book. It allows for rational discussion of the fundamental fluid mechanics, of intraphase mixing, of interphase heat and mass transfer, and of a wide variety of physical, chemical and biochemical applications of each of the gas–liquid–solid systems and subsystems which fall under the classification scheme. The 30-page single-chapter Introduction is thus followed by a 420-page five-chapter section entitled Fundamentals and a 280-page five-chapter section on Applications.

Throughout the course of the book virtually all of the published literature on the subject has been cited and much of it has been systematically incorporated in the exposition of fundamentals and applications. Graduate students and academic researchers working in this field will therefore find the book invaluable. Engineering practitioners working with three-phase fluidized beds or slurry bubble columns can also make good use of this book. The price per page is not exorbitant by current standards.

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