The final chapter of this book is entitled "Surface Tension". The author develops the subject very well, starting with the classical work of Young, LaPlace, Gibbs and Rayleigh, followed by the work of Levich and culminating with descriptions of articles published in the 1980s on surface-tension-driven flows. Perhaps this chapter could have been strengthened somewhat by the inclusion of a discussion of the now classical paper of Pearson [*J. Fluid Mech.* **4**, 489–500 (1958)], in which he explains elegantly that surface tension plays a major role in Rayleigh–Benard convection, the mechanisms for which are of fundamental importance in many of the applications which are of great interest today.

In summary, I think that Professor Probstein has written an excellent textbook which is available for a reasonable price. It satisfies very well the author's intention of addressing the needs of chemical, environmental and mechanical engineering graduate students as well as those in material science and biotechnology.

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Gas–Liquid–Solid Fluidization Engineering, by L.-S. Fan. Butterworth, London (1989). 736 pp. ISBN 409-96179-X. $85.

Three-phase fluidization is among the most complicated and challenging areas of multiphase flow, involving a bewildering array of flow regime and reactor behavior. On the other hand, an increasingly large number of applications involve the use of three-phase reactors. These applications include trickle-bed reactors, catalytic processing in refinery operations, processing of low-grade resources such as oil shale and the increasingly important areas of bioprocessing and waste treatment. Accordingly, there have appeared several review articles on the subject, notably those of Østergaard [in *Fluidization* (Edited by Davidson, J. & Harrison, D.). Academic Press, New York (1971)] and Darton [in *Fluidization*, 2nd edn (Edited by Davidson, J. *et al.*). Academic Press, New York (1985)]. However, because of space limitations, previous review articles have been compact and have necessarily dealt with subsets of the phenomena and applications. This book is a welcome first attempt at a comprehensive treatment of the subject.

The book is divided into three parts: "Introduction"; "Fundamentals"; and "Applications". The first is somewhat shorter than the others, and serves to introduce not only the subject, but also the author's classification of flow regimes and process configurations used throughout the remainder of the book. Included in these regimes are trickle beds and slurry reactors, making the treatment somewhat broader than usually associated with three-phase fluidization, and accordingly making the book somewhat ambitious in its scope. The second major section, "Fundamentals", deals with information regarding hydrodynamics, transport phenomena, hold-up, mixing, flow regime maps etc. associated with the subject. Some of this material, e.g. correlations on hold-up, deals with macroscopic phenomena in an empirical way, while other sections deal with hydrodynamic phenomena, e.g. vortex shedding from wakes of bubbles, in a fair amount of detail. This reviewer found the treatment uneven in this regard, and often wondered about the author's definition of "fundamentals". The presentation throughout the book is almost entirely descriptive, with few if any derivations of the many equations presented. The final section, "Applications" is an interesting compendium of technological applications that exploit the contacting properties of three-phase systems, and relates these applications back to earlier material whenever possible. The text is augmented by a large number of figures, tables, photographs and process schematics. The production of the text is nicely done, in a print that is easy to read. Some of the tables, however, are apparently reproduced from typewritten originals, and as a result are extremely difficult to read. The nomenclature suffers (as does the field) from the requirement of a large number of subscripted quantities, which frequently sends the reader flipping back to the tables of nomenclature in order to follow the text. The literature citations are voluminous, but the discussions of citations in the text are often cursory, involving insufficient detail to describe what might be found in the reference. Accordingly, the book suffers from the drawback of not having *titles* included in the citation. While this would have undoubtedly increased the total length of the book, the publishers missed an opportunity to provide a bibliography of true utility and high impact.

The author states that "the book can be used as a graduate textbook in a three-phase fluidization engineering course or as a supplement textbook to a general fluidization engineering course". The occurrence of such specialized courses in graduate curricula is likely to be rare, and accordingly, it will find limited use as a textbook. Perhaps this is just as well, since in this reviewer's opinion, it would be difficult to teach from this book. In contrast to other, successful, textbooks on fluidization, the subject is not developed from any firm pedagogical basis which is supported by theory and experimental observation. Rather, the text is a wide-ranging compendium of descriptive material that is occasionally so broad and uneven in its treatment that the reader is unable to fit the written text into any sort of overall scheme or general framework. However, the broad coverage is likely to be very valuable to research engineers who need access to information about the behavior of three-phase reactor systems and to the background literature. Anyone seriously interested in the study or design of three-phase fluidized beds should own a copy of this book.

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Handbook of Hydraulic Resistance, by I. E. Idelchik (Edited by E. Fried). Hemisphere, Washington, D. C. (1986). 640 pp. ISBN 0-89116-284-4. $90.

The present edition of the *Handbook of Hydraulic Resistance* is a translation of the second Russian edition of 1975. The author claims that it differs markedly from the Russian first edition of 1960.

The first English edition of 1966 (*Handbook of Hydraulic Resistance*, Israel Program of Scientific Translations, Jerusalem, 1966) has been extensively used by engineers in English-speaking countries because there existed no English-language counterpart to this book.

The book is extremely detailed and has many illustrations of flow passages and diagrams and tables for pressure drop or pressure loss coefficients, which are so useful for the practising engineer in designing single-phase flow systems.

The book is based primarily on the Russian literature with very few references to Western literature. The non-Russian references are all pre-1970. A very useful book to have!

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Fluid Dynamics and Flow-induced Vibrations of Tube Banks, by A. Zukauskas, R. Ulinskas and V. Katinas (Edited by J. Karni). Hemisphere, Washington, D. C. (1988). 290 pp. ISBN 89116-686-6. $85.50.

This book is essentially a compilation of flow research performed in the Soviet Union on the characteristics of single-phase flow that lead to the vibration in heat exchanger tube bundles. This is the strength of the book. It is usually difficult for engineers outside the Soviet Union to access up-to-date Soviet scientific efforts. With this book, heat exchanger research engineers dealing with tube bundle flow phenomena can find in one source an excellent presentation of Soviet efforts.

It appears that considerable effort has been expended by Soviet researchers in attempting to experimentally determine flow details around individual tubes within bundles of varying geometric characteristics operating under a range of flow conditions. For example, considerable discussion and copious experimental results are presented on the effects of pitch, tube bundle geometry, such as staggered, in-line, radial etc., tube location within the bundle on the tube boundary layer separation point, tube to tube gap velocity distribution and tube circumferential pressure distribution. Also, considerable information is presented on the drag of various tube bundle geometries and the drag on individual tubes within a bundle as a function of flow and bundle