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BOOK REVIEWS

Multiphase Science and Technology (Edited by G. F. Hewitt, J. M. Delhaye and N. Zuber), Hemisphere (McGraw-Hill), New York (1982), Vol. I, 513 pp.

This is the first volume in a planned series on multiphase phenomena. The intention is to bring together the work in different fields such as nuclear energy, chemical processing, meteorology, aerodynamics, energetics, etc. This volume was reproduced directly from typed copy. It contains four tutorial presentations designed to bring the nonspecialist up to date.

Spray Cooling of Hot Surfaces is a 97-page chapter by L. Bolle and J. C. Moreau of University Catholique de Louvain, Belgium. It tells how to create sprays and determine the distribution of drop sizes, drop velocities, and the mass flow distribution in space. It discusses the conditions under which drops will bounce, spread, or shatter when they strike a solid. If the solid is very hot, the impacting drops first contact the solid and then lift off slightly as a film boiling or Leidenfrost phenomenon takes over. The significant heat transfer occurs during the short-time contact of liquid and solid. After lift-off, the heat transfer is trivial. A spray contains a very great number of tiny droplets, but those having diameters less than 160 microns remove very little heat. The important droplets are those 300–400 microns in size. About a dozen of the references are European theses and reports which are not widely available. This enhances the value of this chapter.

The Spherical Droplet in Gaseous Carrier Streams is a 181-page chapter by George Gyarmathy of Brown Boveri and Co., Baden, Switzerland. It considers problems such as: how much time is required for evaporation of a liquid droplet suspended in a flowing gas? The problem is complicated, even in the case of severe idealizations. It depends on whether the carrier is rich or lean in vapor, is a continuum or a thin gas, is supersonic or subsonic. It depends on whether the drop is large or small, hot or cold, and whether it will evaporate gradually or boil explosively. The author sets up the differential equations for heat, mass, and momentum exchange. A few cases lead to analytical solutions, many others are described by correlations, the remainder require numerical methods. This is a massive treatment (420 equations and 140 references) of the various theories and models. Dimensionless groups are used throughout, including the familiar labels of Reynolds, Nusselt, Prandtl, Schmidt, Mach, Knudsen, Froude, Sherwood, Biot, Weber, Fourier, LaPlace, Euler, Peclet, Lewis, Bond, Grashof, and Stanton. More were needed so the author defined a Stodola number (a kind of dimensionless time constant for a shrinking or growing drop), a Kelvin number, a new Eotvos number, and a Clausius Clapeyron number. Solved cases are illustrated nicely with graphs or equations. Rarely are these compared to experimental values. There is a deliberate omission of consideration of radiation, chemical reactions, and drop impacts.

Boiling in Multicomponent Fluids is a 106-page chapter by R. A. W. Shock of England's A.E.R.E. in Harwell. The principle topics are bubble nucleation, bubble growth rates, nucleate boiling, film boiling, the maximum heat flux, and flow boiling in channels. The best understood, bubble growth rates, can be predicted for mixtures almost as accurately as for pure components. By contrast, the maximum heat flux shows "bewildering and often conflicting trends". Film boiling is stated to be more efficient in mixtures than for pure components. For nucleate boiling the reverse is usually true. In spite of the excellent list of 160 references, it is evident that the subject of boiling mixtures is poorly understood.

Contact Angles is a 119-page chapter by Jacques Chappois of Ecole Centrale de Lyon, Ecully, France. All explanations are carried out with force balances instead of thermodynamics. Readers are shown the true shapes of drops and bubbles resting on solids (from Bashforth and Adams) to remind us that these are not segments of spheres. There is an excellent discussion of heterogeneous surfaces, and this is used to explain advancing and receding contact angles and hysteresis. The longest section, 16 pages, deals with the wetting tensiometer for obtaining contact angles. This uses a motor-driven plate, slowly moving vertically into and out of a liquid. The existence of a significant spreading pressure of adsorbed gas films on solids which are partially covered with a liquid is asserted. Chappuis stresses that this conclusion disagrees with the views of others such as Zisman, Good, Fawkes, and Neumann.

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Heat Exchangers (Edited by S. Kakac, A. E. Bergles and F. Mayinger), Hemisphere (McGraw Hill), New York (1981), 1131 pp., $95.00.

The book *Heat Exchangers* edited by Kakac, Bergles and Mayinger, represents an archival record of the NATO Advanced Study Institute, held in 1980. It is divided into eight main parts: classification of heat exchangers; thermal hydraulic fundamentals survey for both single- and two-phase flows; design considerations, concerning rating, sizing and optimization of heat exchangers; current status regarding advanced surface selection and performance; operational considerations regarding transient response, dynamic behavior, vibrations and fouling; unresolved problems and suggestions for further research and development.

In the first part, classification of heat exchangers is addressed. It is a self contained chapter, illustrating most of the common heat exchangers encountered in process industry. It can be utilized as an introductory chapter for any course on heat exchangers, even for undergraduate students.

The second and third parts deal with the thermal hydraulic fundamentals of air cooled, staggered and in line tube bundles, yawed tube bundles, compact, concurrent flow double pipe, plate and fluidized bed heat exahangers. These chapters seem to be aimed towards heat transfer engineers in industry since it assumes an *a priori* deep knowledge of the foregoing subjects. It suggests, in most chapters, cook-book formulae typical to a handbook and provides no easy way to comprehend basic principles of the given data.

The fourth part deals with heat exchangers design. By far this part of the book seems to be the most significant. Both numerical and analytical approaches are illustrated for the most commonly used heat exchangers. It lacks, however, a discussion of cost effectiveness. This very important topic seems to be ignored almost totally in the book.

The fifth part presents a short up-to-date survey on advanced surface selection and performance. The general principles and direction of current research is provided in two introductory chapters on single- and two-phase heat transfer augmentation.

Guidelines and words of caution are included in a subsequent chapter on the application of heat transfer augmentation techniques. The backbone of these chapters is a full and useful list of numerous references. However, only a brief discussion is made on the various techniques and no real insight is provided. The reader is repeatedly referred to other sources for further discussion and only one chapter describes in full a novel technique to enhance heat transfer by a new form of plate fin.

Operational considerations are presented in the sixth part. This part is addressed to some of the most difficult aspects of heat exchanger practice, namely, transient response, dynamic behavior, vibration and fouling. Consequently, it is often overlooked by engineers. Since this book seems to be aimed mainly towards design and field engineers in the process industry, incorporation of this chapter in the book is vital.