cuss how the effects of molecular size and shape, molecular flexibility, intermolecular order and bonding, macrostructure, and additives are seen in processability, physical and chemical properties, and applications. There is a final brief review of most of the commercially important polymers in which properties and applications are compared. An attempt is made to relate price to performance, but because 1967 nominal list prices are used, the results are at best qualitative.

The extensive reliance upon secondary sources for data, the most recent of which was published in 1967, results in the exclusion of almost all developments in the last 8 or 10 years. High temperature polymers are mentioned only in passing. The book is further marred by excessive repetition of definitions, tables, and graphs. As is necessary for a work of the scope attempted, only generalizations can be given without adequate detail for the design engineer or practicing processor. A few erroneous statements appear; for example, the myth is perpetrated that fluorinated polymers decompose explosively with the formation of toxic gases, and it is stated that polyvinyl alcohol is infusible.

This book will be useful at the intermediate student level (where it undoubtedly originated), to practicing engineers seeking a generalized survey of polymers and their properties, and to more serious practitioners who need a starting point for detailed projects. The compilation of data from several sources will be welcomed by theorists.

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Metal-Air Batteries and **Fuel Cells,** D. P. Gregory, Mills and Boon, Ltd., London. 1972. 79 pages and 69 pages respectively. Both about $4.00.

These two short books provide valuable supplementary material for undergraduate courses in which recent developments in battery technology are discussed. A course in introductory chemistry is adequate preparation for either one, and the many excellent photographs and diagrams give a good sense of the physical construction of these new power sources. Unfortunately neither book has student problems or exercises, although both have bibliographies which will direct an interested student to further reading.

Metal-Air Batteries is the better of the two by far. Gregory shows himself to be intimately familiar both with the history of metal-air batteries' development and with their detailed function. One of the most interesting parts of this book is its appendix, which summarizes the state of the art in a very wide variety of new battery systems and compares metal-air batteries with some of their competitors. The concepts of energy density and power density are used, and the economics of electric vehicle applications are treated in a sensible way.

Fuel Cells is less successful. First of all, the field is much larger and more highly developed, particularly in its theoretical aspects, and whatever experience Gregory has had is not sufficient for the very difficult task of summarizing a complex field in less than 70 pages. Although the hardware is well-described, the discussions of theory are very weak: concepts of efficiency and reversibility are confused and virtually no useful quantitative expressions are given. The economic aspects of fuel-cell technology have not been clearly separated from the need for special purpose applications. For example, hydrazine fuel cells are virtually dismissed because they require a relatively expensive fuel, but the implication is made that platinum-based fuel cells might indeed be economical. This is, of course, precisely the opposite of what an intelligent crystal ball gazer might predict: Platinum, being a scarce resource, will certainly become far too expensive for any but the highest-priority special purpose applications. In contrast, a concerted development effort on hydrazine production might possibly introduce substantial economies of scale. Thus, at some time in the future when gasoline is considerably more expensive than it is now, hydrazine might indeed turn out to be the cheaper fuel.

Whatever the future may bring, however, these books will certainly find considerable use in present-day undergraduate teaching.

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Instrumentation in the Chemical and Petroleum Industries, Vol. 8, Irving G. Young, (ed), Instrument Society of America, New York (1972). 109 pages. $9.00.

This book, a collection of papers concerning control instrumentation, emphasizes safety, intrinsic and otherwise, in the design, operation, and maintenance of instrumentation systems during the start-up, running, and shutdown of a process. The subject coverage essentially is a study of failures due to nonideal conditions. A general theme is that these conditions can be minimized by proper design engineering and process engineering associated with plant construction and daily on-stream operation through conventional instruments or sophisticated supervisory computers. The introduction is an excellent eye-opener or memory-jogger. It concerns plant case histories of catastrophic events and it critiques the results in each case with 20-20 hindsight.

Material in these papers contains examples of malfunctions that are not exactly common; thus the book has great value in pointing out those uncommon pitfalls that usually are not studied in textbooks. The authors bring out the importance of redundancy or diversity balanced against economic considerations, but never at the expense of personnel, process, and plant safety. They also present pertinent points gleaned from experience, as well as other information pertaining strictly to theoretical applications. In those papers dealing with design engineering, the question—"What if?" is continually reviewed to anticipate and prevent catastrophic events in future plants. Once a process is in operation, the emphasis shifts to remembering Murphy's Law—"That which can happen, will." The importance of permanent records also is emphasized as is adherence to ISA and NEC Standards with the additional consideration of OSHA.

The book should be of value as a reference book to an academician and will be of even greater value to process engineers of limited experience and to many old-timers as well. The subject matter is pertinent both to engineers and to instrumentation foremen.

A point not emphasized strongly in the papers is how well a human could and should enter the control loop without upsetting the process. An experienced operator needs to enter the loop for one of the following reasons: to make fine adjustments, to manually override, or to make changes in the set-point of a controller or a program change in a supervisory computer. This need results from his expertise in the process. No matter how much redundancy or diversity is built into the system, human wisdom should be considered. An example is the automatic light dimmer on an automobile traveling at relatively high speed around a curve having reflective guard posts. The control loop functions normally, but it dims your lights at the wrong time. Man, you'd better resort to manual override quickly or you're in trouble.

Nevertheless, considering all features

in the book, this reviewer would rate it highly compared with other publications having similar topics and formats. It is easy to read and permits a rapid selection of those chapters or sections pertinent to a reader's immediate need.

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Heat Transfer, J. P. Holman, McGraw-Hill, New York (1972). 462 pages. $13.50.

Elementary textbooks which introduce a potentially difficult subject without overly rigorous mathematical treatments and yet without oversimplification are not very common. Professor Holman has succeeded in writing a well-balanced text in heat transfer for the beginning engineering student. The student is introduced to the concept of energy balances in the very first chapter where the three-dimensional heat conduction equation is derived and convection and radiation are also introduced. Since, however, only a background in ordinary differential equations is considered a prerequisite, the subsequent chapters on conduction either consider cases which are easily reduced to ordinary differential equations or, when this is not possible, simply present the solutions. By including a chapter on the elements of fluid mechanics, Professor Holman makes it unnecessary to have a course in fluid mechanics as a prerequisite. The derivation of the laminar boundary layer equation and the use of the von Karman momentum integral equation are clearly demonstrated. Turbulent effects, separation of boundary layers, and more complicated geometrics are accounted for by including a chapter on empirical relations for forced convection heat transfer. The best chapter in the book is that on radiation heat transfer. By means of careful diagrams and step-by-step derivations, shape factors are explained and with extensive use of the electrical analogue solutions, too, complicated radiative heat transfer cases have been illustrated. This use of the electrical analogue will be of considerable help to the student's understanding of the subject. The chapter on heat exchangers is adequate for an elementary text, as also that on condensation and boiling heat transfer where empirical relations have been presented. Insofar as the chapter on mass transfer shows the student the analogy between heat and mass transfer, it serves its purpose; otherwise it is quite inadequate and would be better ignored. The last two chapters are what may be called in today's parlance *relevant* and introduce the student to such concepts as magnetofluidynamic systems, ablation, and to heat transfer in the environment. The treatment shows how the field of heat transfer participates on the frontiers of present-day technology and also how products of technology and natural heat sources combine to affect our ecology. There are numerous examples solved in the text, and references cited at the end of each chapter would satisfy any interested student's needs.

There are two minor deficiencies in this book. In a book presenting as many correlations between dimensionless groups as this one, no discussion of dimensional analysis appears. Also, despite the author's claim in the preface, there are few problems at the end of the chapters which extend the subject matter or challenge the student's understanding of the subject.

Although I would not recommend this book as a reference volume, as indeed it is not intended to be, people in industry who need an elementary text, and beginning engineering students will find this a thoroughly satisfactory book.

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Transport Phenomena in the Cardiovascular System, Stanley Middleman, Interscience, New York (1972). 299 pages. $19.95

The Transport Phenomena phenomenum has spilled over into physiology and related fields, with a generally beneficial effect. Author Middleman has studiously surveyed the literature which deals with engineering-type analyses of cardiovascular mass and momentum transfer and compiled some of this material into a very readable book. The purpose of the book is to show both engineers and biologically-trained readers how the transport phenomena approach can be utilized in physiological and biophysical studies.

The material covers the mechanical properties of the large blood vessels, pulsatile flow of a Newtonian fluid in large vessels, the flow properties of blood and blood flow in small vessels, models of oxygen transfer within blood and from blood to the surrounding tissue, mass transfer across semipermeable capillary walls, compartment models of the circulatory system, single organs and the entire human body, and microscopic-level models of organs. Usually, the results of modeling are compared with experimental data.

The various topics are treated in varying degrees of completeness. The discussion on the mechanics of large blood vessels is very good, probably reflecting the author's interest since this topic is closely related to his area of expertise. On the other hand, the section on blood viscosity and the dynamics of the microcirculation is relatively weak: important work is not mentioned; viscometric data on red cells suspended in saline, on defibrinated ox blood, and on red cells in plasma (blood) are all incorrectly considered representative of human blood behavior; a constitutive rheological equation valid over a limited shear rate range is used over a wider range, an invalid peripheral layer model is presented to describe blood flow in small diameter tubes, etc. These omissions or confusions probably arise because the author has not been involved with research in this area and is mainly repeating the work reported in a narrow selection of the pertinent literature. However, most topics seem to be presented at a competent level.

A partial differential equation is the main starting point of most of the book's presentations. Bessel functions and complex numbers occasionally show their faces. The interwoven text does a good job of introducing background information, in smoothly carrying the mathematical development along, and in relating the model results to experimental facts. A good senior or graduate chemical engineering student should be able to read and understand this book with little difficulty. Most physiologists probably do not have the mathematics background needed to fully appreciate the book.

For a person whose curosity about the interaction between chemical engineering and medicine needs to be satisfied, this is an excellent book. For the person interested in initiating research in this area, the book is still an excellent survey point, but sections of it may be incomplete or incorrect to varying degrees of seriousness. The book also can be advantageously used as a starting point in developing material for chemical engineering courses.

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