ChE book reviews

LIQUIDS AND SOLUTIONS: STRUCTURE AND DYNAMICS

By Peeter Kruus. Marcel Dekker, New York 1977
Reviewed by Keith Gubbins, Cornell University

Substantial advances have been made in both the theoretical and experimental methods for studying liquids over the past ten years. These include, on the theoretical side, the development of successful perturbation theories and integral equation methods, and the application of these to liquid mixtures; on the experimental side there have been great improvements in both spectroscopic and scattering techniques, as well as much careful and elegant work on phase equilibria and properties near critical points. These advances have been enhanced by the rapid development of computer simulation techniques, and their application to liquids of practical interest (water, hydrocarbons, etc.). This situation has led to an outpouring of books on liquids recently. (A quick perusal of my bookshelf showed nine such books in the last few years, and this is by no means inclusive). Thus the book by Peeter Kruus must be viewed to some extent in the light of these other volumes.

The book is intended for seniors and graduate students who have had some previous exposure to thermodynamics and statistical thermodynamics. In the Preface the author states that the purpose of the book is to give an overview of the various theoretical and experimental methods used for liquids, and thus prepare the reader for more advanced books and articles on the topic. This is a laudable aim, but a difficult one. Unfortunately the book does not achieve this goal as well as one would hope. Beginners will be frustrated by the lack of detailed explanations and derivations; phrases such as "it can be shown that" occur with irritating frequency, while in other cases equations are merely written down and the reader is left wondering whether or not he should understand where they came from. At the same time, the book is not particularly useful as a review for more experienced readers, particularly since many of the older methods (cell theory, significant structures, etc.) are included along with only rather sketchy discussions of the modern approaches; the whole is without any depth or critical appraisal of the relative merits of different theories.

The book is divided into three parts. Section A covers the theory of liquids, including intermolecular forces, cell theories, significant structure theory, and distribution function theory. Of particular interest to chemical engineers will be the chapters on liquid mixtures, electrolyte solutions, and transport processes in liquids. Section B covers experimental methods for studying liquids, and includes chapters on thermodynamic, transport property, ultrasonic absorption, dielectric relaxation, infrared and Raman spectroscopy, magnetic resonance and scattering (light, x-ray, and neutron) measurements. Each chapter contains a summary of the underlying theory for the method, a description of the experimental techniques, and results for some typical liquids of various classes (monatomic liquids, organics, water, mixtures, systems of biological interest, etc.). Section C is a brief review of background material, and includes chapters on thermodynamics, equilibrium statistical mechanics, nonequilibrium thermodynamics and statistical mechanics, electromagnetism and quantum mechanics.

The most useful part of the book is Section B. This gives a helpful summary of many of the experimental methods used for liquids. Section A is disappointing in that it attempts to cover too much; by briefly describing a wide range of models and theories (of varying degrees of usefulness) the readers appetite is whetted, but not satisfied. However, the references for further reading given in this section are helpful.

The book has more than its share of conceptual errors. Thus the very first sentence is incorrect, where it is stated that the dynamics in liquids is ultimately determined by the intermolecular forces; the influence of molecular mass and moment of inertia is not mentioned. A further example occurs on page 17, where an example of three polar molecules (a, b and c) close together is used to explain many-body forces; the fact that the presence of c influences the orientations of a and b is not necessarily an indication that pairwise additivity of forces is invalid.

This book cannot be recommended as a text for the beginner wishing to study liquids, although it is of some use for an overview of the subject and a source of references. The discussion of experimental methods is also valuable, and the book can be recommended to some readers on that basis. However, the student wishing to get started in the field of liquids would do better to study some of the other recent books, for example Kohler's "The Liquid State" or "Liquid State Chemical Physics" by Watts and McGee. □