J. Fluid Mech. (1998), *vol.* 373, *pp.* 380–381. Printed in the United Kingdom

BOOK REVIEW

Fluid Mechanics of Viscoelasticity. By R. R. HUILGOL & N. PHAN-THIEN. Elsevier, 1997. 487 pp. ISBN 0 444 82661 0. $264.50.

Rheology is a multi-faceted field interfacing a number of disciplines in pure and applied science and engineering. It serves as a bridge between Newtonian fluid mechanics and solid mechanics within and beyond elasticity, and it is the natural host of several specialized subjects including mechanics of complex media and particulate fluids, polymer solution dynamics, polymer melt processing, and colloidal system science. The student of rheology is required to invest several years of study in order to become acquainted with the fundamentals, grasp the important physical concepts, develop analytical skills, and recognize the significance of solved and outstanding problems. The author of a book on rheology is faced with the extraordinary task of keeping up with the vast literature, isolating the key ideas that underlie classical and modern developments, and presenting them in a manner that emphasizes the coherence of the field, while disguising the historical truth that different branches of rheology have been developed by distinctly different communities of researchers. The difficulty is compounded by the necessity to extend the presentation into the realm of numerical methods; this is no longer an option.

The authors of this book have made an admirable and largely successful effort to overcome the aforementioned difficulties. The product of their hard work is a remarkable text that can be described, without exaggeration, as a little treasure box. The fundamental aspects of viscoelasticity are treated with clarity and in sufficient depth, supporting material is explained in appendices and with adequate references to sources, specialized topics are consistently motivated from the perspective of scientific curiosity, and there are a multitude of new ideas that extend beyond the state-of-the-art knowledge and suggest topics for further research. I have taught parts of this material to graduate classes at the University of California, and I was pleased that the organization of my notes parallels that of this book; I would have certainly chosen this book as a text, if it had been available at that time. Much of the material I read was new, but my learning curve was steep; I attribute this to the high quality of writing and the systematic exposition of ideas. I often found myself compelled to rush back and re-read sections after digesting them for several days.

The book is organized into three parts on General Principles, Constitutive Modelling, and Analytical and Numerical Techniques. Chapter 1 discusses the kinematics of a flow and builds the analytical machinery needed for the fabrication of constitutive equations. Chapter 2 derives balance equations for mass, momentum, and energy transport. A number of sections in this chapter are devoted to discussing the dimension of fractal shapes, and then addressing the issue of whether or not the integral balances apply to control volumes that are enclosed by fractal boundaries. Chapter 3 discusses the formulation of constitutive equations for a simple fluid. Chapter 4 discusses attempts to derive constitutive equations from dynamical theories of microstructures, with particular reference to dilute polymeric solutions and suspensions of rigid particles. State-of-the-art references are provided throughout this chapter and the key ideas are emphasized. The last three chapters address the shape and nature of general solutions, simple models and complex phenomena, and computational viscoelastic fluid dynamics. To show the broad range of topics included,

I am listing the section titles in chapters 6 and 7: some consequences of the isotropy of the constitutive functional; equations of motion in curvilinear coordinates; viscometric flows; rectilinear motions; non-viscometric flows; dynamically compatible unsteady flows; conditions for identical velocity fields in Newtonian and some non-Newtonian fluids; the role of the second normal stress difference in rectilinear flows; plane creeping flows and the relevance of the first normal stress difference in rectilinear flows; plane creeping flows and the relevance of the first normal stress difference; experiments and theoretical results to delineate a simple fluid; cessation of one history and continuation with another history; linearised stability and bifurcation; qualitative dynamics.

Because of these extraordinary features, one would expect that this book will become the standard choice of a text for graduate courses on rheology, or even comprehensive courses in fluid dynamics. Unfortunately, this will not be the case: the astronomical retail price of $265.5 before taxation, quoted by the University of California, San Diego, bookstore, will be a serious impediment. It appears that the publishers have not realized that rheology is not an exotic topic, and there is a substantial market for well-written books. The reader who has the opportunity to borrow a copy from a library should immediately take advantage of it, and should hold on to the copy for the longest possible time.

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