Elementary Fluid Mechanics

D. J. Acheson, Clarendon Press, Oxford Applied Mathematics and Computing Science Series, 1990, 397 pp., $85.00 (hard cover), $29.95 (paperback).

This is a highly recommendable fluid mechanics textbook for students in applied mathematics, physics, and engineering, set apart by an easy style, a healthy amount of exercises, lots of references to original papers, and a wide coverage of topics. Experimental results are quoted throughout; exercises, some of them quite substantial, run an average of about 14 per chapter, and come along with hints and/or complete solutions. My experience is that the book can function well in a graduate chemical engineering course in fluid mechanics, although probably not all of the material would need to be covered and augmentation might be warranted (for example, there is no mention of boundary conditions involving tangential stresses due to gradients of interfacial tension, no reference to fully developed turbulence, nothing dealing with suspensions, and only one reference dealing with non-Newtonian fluids).

It starts, as do many other books in fluid mechanics, with inviscid flows, followed in Chapter 2 by a short introduction to viscous fluids, where the Navier-Stokes equations are simply stated and used. Chapter 3 gives a fairly comprehensive treatment of waves. Chapter 4 offers a somewhat classical treatment of aerofoil theory, including along the way the usual conformal mapping treatment of potential flows, leading in Chapter 5 to a very nice treatment of vortex motion, and finally connecting in Chapter 6 with the Navier-Stokes equations, including now a derivation of the Newtonian equations of viscosity, very much along the lines initially suggested by Stokes himself. Chapter 7 is devoted to very viscous flows, a subject dear to many chemical engineers, and Chapter 8 to boundary layers. Chapter 9 is devoted to classical stability problems, Kelvin-Helmholtz, Taylor-Couette, and others, reaching up to recent ideas about bifurcations and chaos. Interspersed throughout there are references to Kelvin's vortex ring theory (p. 168), the von Kármán's street (p. 180), Newton's arguments about viscosity as put forward in *Principia* (p. 201), Ossen's improvement of Stokes solution for the flow past a sphere, Prandtl's 1905 paper on boundary layers along with some of the original figures (p. 260), and quotes and original drawings from Reynolds' "An Experimental Investigation of the Circumstances which Determine whether the Motion of Water Shall be Direct or Sinuous, and the Law of Resistance in Parallel Channels" (p. 301), the classical paper where the Reynolds number first makes its appearance. Not everything is old; a few papers published in 1989 are quoted, which for a book published in 1990, it is actually quite remarkable.

The book is advertised as requiring little background but, in fact, the coverage is considerably more sophisticated than a superficial first reading might suggest; I do not think it can be profitably read by a first-time student without some kind of assistance. Nevertheless, it is more of a "how to" book than say D. J. Tritton's *Physical Fluid Mechanics*, which covers roughly the same territory. On first viewing, the material appears deceptively simple [other reviewers have noted this as well; *Physics Today*, December 1991; *J. Fluid Mech.*, April 1991]. For example, Lagrangian concepts, actually used in the chapter dealing with vortex motion, are hidden in exercises such as 1.7, 5.21-2, and 6.13, and sometimes more is assumed than meets the eye. The skeleton, however, is quite good, and I hope that a few things that probably need smoothing out, for example, the first of the two places dealing with reversibility, are taken care of in a future edition.

In summary, this is a book that provides a balanced overall view of fluid mechanics. It is enjoyable to read and gives an all too rare glimpse into the historical setting of some of the most important developments in the history of the subject. It is most definitely a book that can be recommended with confidence as supplementary reading in any serious fluid mechanics course.

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