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BOOK REVIEW

Wave Propagation in Gas–Liquid Media, by V. E. NAKORYAKOV, B. G. POKUSAEV & I. R. SHREIBER. CRC Press and Begell House, Boca Raton (1993).

The book, translated from Russian, deals mainly with theoretical and experimental investigation of two topics: wave propagation in bubbly media, and instability and wave propagation over falling liquid films on a vertical wall.

In the first chapter, entitled "Acoustic and Shock Waves in Homogeneous Gas– and Vapor–Liquid Mixtures", the authors generalize the one-dimensional theory of sound and shock-wave propagation in the case of a two-phase medium treated as an effectively homogeneous continuum.

The second chapter, entitled "Dynamics of Gas and Vapor Bubbles", is devoted to the dynamics of a single bubble—the Rayleigh problem and its generalizations. A comprehensive survey of theoretical and experimental works dealing with dynamics and heat transfer of a gas bubble, growth and collapse of a vapor bubble, and other related processes, is presented.

In the next two chapters, entitled "Wave Processes in Gas–Liquid Systems" and "Wave Propagation in a Liquid with Vapor Bubbles", the description of wave processes in gas–liquid media distinguishes explicitly the dynamics of a gas (or vapor) phase from that of a continuous liquid phase. The latter means that in contrast to the first chapter, the bubbly media are not considered as an effective homogeneous continuum. The chapters contain a detailed discussion of up-to-date theoretical and experimental results.

In the third chapter the authors consider dilute bubbly media and under certain assumptions arrive at the Boussinesq and Korteweg–de Vries–Burgers equations, as well as at the Klein–Gordon equation, as the governing equations of the wave processes in some particular problems. The authors have contributed significantly in this area, and the systematic account of these problems is of considerable interest.

The fourth chapter deals with systems with vapor bubbles and slug liquid–vapor systems. In particular, the interesting effects of wave damping and amplification are discussed.

Chapters 5 and 6, entitled "Wave Processes on the Interface of Two Media" and "Wave Flow of Liquid Films", are devoted to instability and wave propagation in liquid films falling down over a vertical wall. The description is largely similar to that of shallow water approximation.

In the seventh chapter, entitled "Survey of Basic Calculation Formulas and Relations of Wave Dynamics of Gas– and Vapor–Liquid Media", the authors present a survey of basic formulae.

The authors treat the theme of the book both experimentally and theoretically, developing the theory on the basis of experimental evidence and comparing the solutions with experimental data. However, some important details seem to be completely missing. A bubble in pressure and shock waves is treated as a sphere disregarding the possibility of symmetry loss and formation of a jet-like structure (recorded photographically long ago). The latter certainly affects the dynamic behavior of the bubbles as well as the governing equations for wave propagation in bubbly media.

The discussion of the dynamics of a single bubble contains no reference to forced oscillations and resonance frequencies.

In considering non-equilibrium evaporation and its effect on the dynamics of a bubble, the authors continue to use temperature (which cannot be defined in the case at hand) and overlook the Knudsen layer which may occupy the whole bubble. As a result, the treatment of the non-equilibrium evaporation effects seems to be inadequate. Instability of a rapidly evaporating surface, which also leads to symmetry loss in bubbles, is completely ignored.

The very interesting phenomenon of combustion wave propagation in bubbly media and shock wave propagation in liquid foams are not referred to, nor are the dynamics of gas–liquid systems under the action of vibration in sonic fields, which are of engineering importance.

In section 5.1 the authors present the classic linear theory of Rayleigh–Taylor instability of an interface of two liquids with the heavier liquid above the lighter one. Then they present an experimental example of instability of a liquid layer driven by a pressure differential generated by an explosion inside the liquid. This is also Rayleigh–Taylor instability (because it sets in due to the acceleration imposed on the liquid towards its free surface). However, the theory of this phenomenon is distinct from the calculations presented in 5.1 and is not even mentioned. Thus, the experimental and theoretical parts do not match and it is unclear why the authors put them together.

Numerous known nonlinear results on Rayleigh–Taylor instability, as well as on Kelvin–Helmholtz instability (which is considered in section 5.2), are also not mentioned at all.

In the discussion on falling films nothing is said of modern nonlinear results obtained by the boundary integral methods.

Spin coating flows, which are known to be similar to those in falling films, are not considered.

In section 5.7 only varicose disturbances of elastic tubes are accounted for, whereas in many important cases there is also bending instability, which is not mentioned.

From our point of view the theme of chapters 5 and 6 is identical and the reason for their separation is not clear. Moreover, equations [6.3], which are one of the central points of chapter 6, had already been obtained before as [5.101]–[5.102] in chapter 5. Some differences in the coefficients of the quasi-one-dimensional momentum equation in [6.3] and [5.101]–[5.102] are indistinguishable under the adopted approximation. Therefore [6.3] cannot be considered as an improvement of [5.101]–[5.102]. Moreover, in chapter 6 there is one more set and derivation of the same equations—[6.44]–[6.45]. The approach used to derive all these equations is called on p. 162 the Karman–Pohlhausen method, which sounds rather misleading, since the flow under consideration is not flow in the boundary layer.

Nothing is said about the application of the Kuramoto–Sivashinsky equation to falling films and predicted chaotic flow regimes. Nothing is said about a thin layer approximation and evolution equation of a Benney type. Many important results related to wavy flows of liquid films on vertical and inclined surfaces are therefore overlooked.

A motivation for derivation of [6.27a], i.e. for going to higher order terms in ϵ is not explained. Its lower order approximations, [6.26] and [6.27] are all ill-posed and this has to be mentioned to prevent a non-experienced reader from using those equations.

Sections 2.1–2.6, 3.1–3.6, 3.8, 3.9, 4.4, 5.1, 5.2, 5.5, 6.7–6.9 are identical or very close to sections 11.1–11.2, 12.1–12.6, 12.8, 12.9, 13.4, 7.1, 7.2, 7.4, 7.5, respectively, of the book by S. S. Kutateladze and V. E. Nakoryakov "Heat and Mass Transfer and Waves in Gas–Liquid Systems", Nauka, Novosibirsk, 1984 (in Russian), which is not even referred to in the present volume.

Finally, something should be said about the editing, which is called "masterfully done . . ." in the Preface to the English edition. We have serious doubts on this point not only because of the lame English (including the terminology; too many examples could be given), but because Western names are systematically misspelt: Rankine became Renkin, Riemann—Rieman and Hugoniot—Gugonio. It should be added that in the list of references the most papers are cited in their Russian edition (which makes them unavailable to the Western readership), whereas they have been translated into English and might be found in the library downstairs.

From our point of view, the most interesting and useful part of the book is the original experimental and theoretical data on some nonlinear effects characteristic of wave propagation in two-phase media and falling films. The book may be of use to engineers and researchers specializing in the field of wave dynamics of gas–liquid media.

A. L. YARIN and P. B. VAINSHTEIN
Faculty of Mechanical Engineering
Technion—Israel Institute of Technology
Haifa
Israel