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BOOK REVIEW

Interfacial Transport Processes and Rheology, by D. A. EDWARDS, H. BRENNER and D. T. WASAN. Butterworth-Heineman, New York (1992). US $75.

This delightful book deals with the theory of the flow and rheology of systems in which liquid/fluid boundaries play an important role. Since such interfaces are encountered in a large number of industrial, biological and ecological applications, the field is of tremendous importance and a general treatise, as provided by Edwards *et al.*, is extremely useful.

The book is written in two complementary parts: Part I deals with a macroscopic description of a liquid/fluid interface, which is regarded as a two-dimensional boundary that possesses certain properties such as interfacial tension, interfacial shear and dilational viscosity, surface excess pressure etc. The bulk properties of the two phases separated by the interface are discontinuous, while velocities and stresses are varying continuously over the interface. In Part II, a microscopic view is adopted in which the interface is considered as a three-dimensional transition zone through which all properties vary continuously.

After a short historical review, an outline of practical applications and a definition of the basic properties of interfacial rheology, the general theory of transport processes involving liquid/fluid interfaces, is presented. From overall balance equations, general differential equations are derived which describe the rate of change in mass, linear and angular momentum, mass of dissolved or suspended material, energy and entropy. This is done for both bulk and interfacial properties. The same approach is used for the relevant boundary conditions (continuity of normal and tangential stress etc.). In specific examples these equations are reduced to more manageable expressions that can be solved either analytically or numerically. Additional examples are given in the problems at the end of each chapter. Whenever possible comparison between bulk and interfacial properties are made, e.g. shear viscosity vs interfacial shear viscosity, bulk stress tensor vs surface excess stress tensor etc. These comparisons are very useful and enhance the transparency of the theory. Next, the theory is modified to allow for non-Newtonian surface behavior, while continuing to treat the bulk properties as Newtonian. Finally, gradients in surface tension are considered, induced by flow or temperature gradients, which lead to Marangoni effects. Again, simple and insightful examples are given to illustrate the general theory.

Besides theory, several chapters deal with experimental techniques to measure various dynamic surface properties, such as dynamic interfacial tension, dilatational elasticity and interfacial shear, and dilatational viscosity. These chapters are extremely useful for researchers who want to characterize interfacial properties. Various techniques are compared and their advantages and disadvantages discussed. A minor shortcoming is that a clear link is not always made between the theory and the quantity that is being measured. Sometimes an equation is quoted from the literature, relating a surface property with experimentally measurable parameters, without stating how it relates to previously described theory (this could have been done in the problem section), or sometimes no relation at all is given between experimentally measurable parameters and surface properties (e.g. in the section dealing with light scattering).

Part I finishes with treating a variety of relevant and important topics, ranging from the stability of films, emulsions and foams to the hydrodynamics of the films and the rheology of foams. Except for consistently misspelling the name of the famous scientist, **van der Waals**, (especially annoying to a Dutch reviewer), these chapters clearly show the relevance of this field to various applications.

In Part II (about one third of the book), the various interfacial parameters entering the macroscopic description are derived from a rigorous mathematical theory in which the surface is treated as a three-dimensional continuum. Making use of singular perturbation theory, an expansion is made in the small parameter $\epsilon = l/L$, l being a microscopic length scale and L a macroscopic one. All surface properties are then unambiguously expressed in terms of ϵ . Besides applying this microscopic theory to interfaces, it is also applied to three-phase contact lines, despite the fact that this topic is not treated in Part I.

The only omission in this book is that little or no mention is made of the physical–chemical aspects of interfacial phenomenon, although I guess this could warrant a whole book on its own. No effort is made to relate the various interfacial parameters needed to describe transport processes with molecular theories of surfactants. Surfactants can behave as a two-dimensional gas, liquid or solid, the molecules can be standing up straight or be tilted. Intra- and intermolecular forces determine adsorption and desorption kinetics at interfaces and affect diffusion constants. The same applies to the sections dealing with non-Newtonian interfacial behavior. Interfacial shear thinning and related phenomena are not explained in terms of molecular motion; instead use is made of constitutive equations, modeled after similar bulk constitutive equations.

Overall this is a delightful book which is a "must" for every student and researcher dealing with the flow of systems in which interfacial phenomena play a role. The theories are presented clearly and with plenty of physical insight. The examples chosen to illustrate the theory (expanding bubbles, sedimenting drops, thinning films etc.) help tremendously in getting the usefulness of the adopted approach across.

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