INTERFACIAL PHENOMENA: EQUILIBRIUM AND DYNAMIC EFFECTS

by C.A. Miller and P. Neogi
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The subject of interfacial phenomena is increasingly capturing the attention of chemical engineers as they are called upon to solve problems dealing with surfactants, thin films, coatings, natural and synthetic fibers, adhesives, lubricants, foams, pigments, powders, aerosols, emulsions and other materials for which surface properties play a dominant role. These properties are recognized as important both in the traditional fluid-phase separation processes such as distillation, absorption and extraction, and in the emerging technologies of composite materials design (polymer-fiber, polymer-ceramic, metal-ceramic, *etc.*) and bioprocessing. The underlying science of interfacial phenomena, however, is rarely treated in courses in chemistry, physics, or engineering. This excellent text should do much to encourage its inclusion in chemical engineering curricula.

While a number of books on interfacial phenomena or surface and colloid science are presently in print, this book is unique among them in giving a comprehensive treatment to nonequilibrium flow and transport behavior. It treats flowing and deforming waves, films, drops, bubbles and jets, and considers situations in which heat or species transfer across fluid interfaces is taking place. It thus describes the range of important phenomena (the Marangoni effects) in which the potential energy of unequilibrated phases is converted, by means of the interface, into the kinetic energy of spontaneous convection. It also deals with the damping and stability effects of surfactant films.

The organization of the book and its topical coverage are consistent with the general objective of the authors "to combine in one text an account of nonequilibrium interfacial phenomena such as wave motion and Marangoni flow with enough background on the fundamentals of interfaces to enable the dynamic analyses to be understood and to provide an initial overview of the field." The first four chapters give the background material, and deal with interfacial tension, wetting and contact angles, colloidal dispersions, and surfactants, respectively. The material is developed in a manner which anticipates the subsequent chapters dealing with the dynamics of interfacial systems. Many of the approaches used are novel and provide new insights into old concepts. For example, the "mechanical" derivation of the Young-Laplace equation introduces the use of the control volume embracing the interface (the "pill box") upon which force balances, material balances, enthalpy balances, *etc.* can be drawn. This approach reveals more clearly than others the nature of the various "surface excess" quantities, the equivalence between the "force" and "energy" definitions of interfacial tension and the approximations entailed in the usual formulation of the Young-Laplace equation. Finally, it sets the stage for the development of the boundary conditions to the thermal energy and convective diffusion equations.

The final three chapters, constituting nearly half the text, deal with interfaces in motion-stability and wave motion, transport effects on interfacial phenomena, and dynamic interfaces, respectively. These chapters are the centerpiece of the book. They presume prior knowledge of basic fluid mechanics and transport phenomena, but include sufficient development of such techniques as linear stability analysis and matched asympotic expansions that these topics may be used in the analysis of a variety of problems.

The text is written as a teaching tool. The style is lucid and expository. Each chapter contains several solved example problems and is followed by an ample set of problems to be solved by the reader. Some are quite challenging, and many represent topics of current research interest. Each chapter also contains a full listing of references, both to other textbooks and to literature articles.

If there is any criticism at all to make of this text, it is its brevity. Many topics have been left out altogether: adsorption equilibria and dynamics, kinetic phenomena of colloids (sedimentation and diffusion), the rheology of colloids, electrocapillary phenomena, and others. Also, very little attention is given to experimental techniques. Given the length of the text, however, the choice of material provides a coherent whole. It is a book which anyone interested in interfacial phenomena, whether teacher, student, or practitioner, should own. □