$\sqrt{gH} = 0.5\ m/s$ is small when compared with the smallest observed velocity which is equal to 4.7 m/s.

Finally, N_* is not influenced by the geometric parameters (D, L, internal structure of the injection device). But D and L influence the onset of oscillations. It should be only noticed that a disturbance induced by a transition of the flow pattern is larger when the diaphragm aperture is smaller and that the frictional pressure drop is nearly proportional to the length of the channel. Hence, a disturbance is easily amplified when D and L are small. Detailed results (Adler, 1975) are shown to follow these trends.

CONCLUSIONS

An oscillatory phenomenon induced by the introduction of a diaphragm in a horizontal air-water, two-phase flow was analyzed.

The experimental frequency is of the same order of magnitude as the frequency of a continuity wave. However, in our case, the void fraction profiles vary through the wave, while the spatial mean void fraction is constant.

The experimental frequency was shown to be given by an empirical formula in which only the mean superficial velocities of each phase and the length of the setup have an effect. This is thought to be characteristic of this type of instability.

NOTATION

α = local void fraction
D = aperture of diaphragm
g = acceleration of gravity
H = height of channel (= 24 mm)
L = length of setup
N, N_* = dimensional, nondimensional resonance frequency
p = pressure
r = time
$\bar{u}_G, \bar{u}_{G,m}, \bar{u}_{G,A}$ = mean superficial velocity of the gas phase for an arbitrary pressure, mean pressure of the setup, atmospheric pressure
$\bar{u}_L$ = mean superficial velocity of the liquid phase
x, y = Cartesian coordinate system (Figure 1), the origin 0 is at the beginning of the injection device, within the vertical symmetric plane of the channel and at the upper wall

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BOOKS

Gas-Solid Reactions, J. Szekely, J. W. Evans and H. Y. Sohn, Academic Press, 1976. 400 pages. price: $39.50.

This a textbook intended for graduate students majoring in metallurgy or chemical engineering with specific interest in gas-solid reactions. Of the eight chapters, the first five chapters (half the book) are devoted to the derivation of rate equations based on several idealized models of gas-solid reactions, with appropriate mathematical problems for exercise. In fact, the major emphasis in the book is on the mathematical treatment of heat and mass transfer accompanying various types of idealized gas-solid reactions with perhaps a biased slant to their grain model. Although the authors do caution the student that good judgment should be exercised in the application of theoretical rate equations to experimental data, they do not give adequate examples of departures from idealized reaction models that are often encountered even in well-thought out experiments. A conceptual analysis of a reaction to be studied is, of course, a priori requisite to the design of a particular experimental method, and the interpretation of the results, however, greater emphasis should have been made on frequently observed departures from idealized reaction models. However, the authors' mathematical treatment of the idealized gas-solid reactions is clearly stated, and the equations given for numerous types of reaction models will be of much value to those who study the gas-solid reactions. The review of past work on oxidation of metals and reduction of metal oxide is highly condensed. In fact, no mention is made of internal oxidation, sulfidation, nitriding, etc. of alloys which is a subject of some importance to the students of metallurgy. In Chapter 6 the authors give a broad outline of experimental techniques used in the study of gas-solid reactions. The principles of gas-solid reactions in multiparticle systems are adequately presented in Chapter 7. Some examples are given in Chapter 8 of gas-solid reactions of industrial importance, such as iron oxide reduction, roasting of sulfides, SO_2 absorption by solids, coal gasification and incineration of solid waste. These examples are intended for the student's orientation and not for detailed discussion of, for example, heat and mass transfer in the blast furnace stack. Graduate students and those in research laboratories investigating gas-solid reactions will find the book helpful in their endeavors.

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Heat Transfer, 4th Ed., J. P. Holman, McGraw Hill Book Company. 530 pages, price: $17.00.

This is a fine elementary treatment, excellent for a strong first course in heat transfer. Analytical, numerical, and empirical techniques are used to good advantage for a very understandable treatment. The number of problems presented is generous.

In addition to analytical treatment of steady and transient conduction, numerical techniques are also presented. For both forced and natural convection, an integral analysis is given, followed by presentations of empirical results. The nature of thermal radiation is discussed and exchange analysis is by the network method. An introduction to two phase heat transfer systems is given in Chapter 9 on condensation and boiling. The treatment is more abbreviated than one would perhaps wish, but serves as a good starting point. Heat exchanger design presents both the log mean temperature difference and the NTU effectiveness methods. The mass transfer chapter (Ch. 11) is far too brief to be effective. Special topics in Chapter 12 give a helpful introduction to several topics and the final chapter on Heat Transfer in the Environment is timely and undoubtedly will provoke student interest.

The primary set of units used is the SI, with conversion tables given to the English units for those of us who still "think" in the old system.

To restate my initial appraisal: this is an excellent, well put together introductory text on heat transfer. I recommend it.

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Thermochemical Kinetics, 2nd. Ed., Sidney W. Benson, Wiley Interscience, 320 pp., $22.50, New York, 1976.

This book has a subtitle: *Methods for the Estimation of Thermochemical Data and Rate Parameters.* This is more descriptive than the somewhat arcane title and almost directly suggests that the book represents an effort to make accessible to the chemical engineer and the industrial chemist the vast resources of chemical kinetics to predict, understand and control a host of phenomena.

In chemical engineering, group additivity methods have been used for many years to estimate thermochemical quantities dealing with equilibrium systems. Professor Benson has perfected such methods but his originality has been to use these for the estimation of entropies and heat capacities pertaining to the most elusive species of all: those dealing with the so-called activated complex or transition state of chemical kinetics. Many examples are discussed in this book to illustrate the sometimes embarrassing agreement between estimated and experimental quantities. The treatment of S. W. Benson is unique in its scope and it reflects a lifetime of expertise in the field.

Two limitations must be mentioned. First, the treatment is limited to ideal gas phase reactions excluding specifically all reactions with ionic or adsorbed intermediates. Of course, the wealth of processes covered is nonetheless impressive: oxidation, combustion, atmospheric and stratospheric chemistry, pyrolysis etc. The second limitation is more serious: the methods described do not apply to the estimation of activation energies. For the calculation of the latter, Benson and Alfassi have proposed some special semi-empirical rules, the generality of which remains to be tested.

Perhaps the success of this book which amply deserves this second edition, is that its author is not primarily an applied kineticist but a leading theoretical one whose previous work *Foundations of Chemical Kinetics* has been a lasting monument since 1960. This being said, it seems entirely fair to this reviewer to point out an error on page 2 of the present book. For a reaction with a general stoichiometric equation, it is not generally correct to state [eqn. (1.3)] that the ratio of rate constants forward and reverse is equal to the equilibrium constant for the reaction. This was already pointed out years ago by several authors including Denbigh in his classical book on Thermodynamics and discussed again recently [M. Boudart, *J. Phys. Chem.*, **80,** 2869 (1976)].

In spite of this venial sin, Professor Benson's little book is too valuable to be left on library shelves: it belongs to the desk of anyone dealing with thermodynamics or kinetics and who doesn't?

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LETTERS TO THE EDITOR

To the Editor:

In a recent article LeVan and Newman [*AIChE J.*, **22,** 695 (1976)] are critical of boundary layer methods [D. A. Saville, *Chem. Eng. J.*, **5,** 251 (1973); J. F. Harper, *Q. J. Mech. Appl. Math.*, **27,** 89 (1974)] when applied to estimate the distribution of soluble surfactant in the interface around a small gas bubble rising through a liquid. Here the distribution of surfactant fixes the variation of interfacial tension around the periphery and the resultant change in stress changes the terminal velocity of the bubble.

Since boundary layer solutions for problems of this sort are asymptotic representations, the question is mainly one of deciding whether or not the Peclet number is large enough for the desired accuracy. LeVan and Newman used a numerical method to solve the full conservation equation for a Peclet number of 60 and found that the terminal velocity of a small bubble is lower than the Hadamard-Rybczynski velocity by an amount $\kappa C_\infty U_0$. Here C_∞ is the surfactant concentration far from the bubble, U_0 is the Hadamard-Rybczynski velocity and κ is a numerical factor, 1.9×10^8 cm^3/g-mole according to their numerical solution. Boundary layer theory gives precisely the same functional form and κ, calculated using Eq. 16 of Saville (1973), turns out to be 2.1×10^8 cm^3/g-mole.

It is true, as pointed out by LeVan and Newman, that a boundary layer model neglects (in the first approximation) diffusion in the θ-direction along and near the surface. However, the qualitative features of the concentration field are very similar to those predicted by the full numerical solution except near the rear stagnation point. There, although the boundary layer solution exhibits weakly singular char-