(Continued from preceding page)

$$U_s = k\,U \qquad (15)$$

where k is a proportionality constant greater than unity which accounts for local slip. Equation (15) is integrated over the flow cross section as in Equation (1), using the distribution parameter as defined by Equation (8), to give

$$\frac{\overline{U}_s}{\overline{U}_w} = \left[\frac{1-\alpha}{\dfrac{K}{k}-\alpha}\right] \qquad (16)$$

This author (*4*) analyzed slug flow where the local gas velocity has two components; it is rising through the liquid with a velocity given by the Taylor relationship (*5*) and, at the same time, it is being carried along at the stream velocity. Thus

$$U_s = U + C\sqrt{gD} \qquad (17)$$

where g is the acceleration due to gravity and D is the diameter of the enclosing channel. Again, integrating Equation (17) over the cross section of the stream as in Equation (1), using Equation (8) and noting that the buoyant component of the slug velocity is constant, we obtain

$$\overline{U}_s = \frac{1}{K}\overline{U} + C\sqrt{gD} \qquad (18)$$

Using Equation (3) in Equation (18) gives

$$\frac{\overline{U}_s}{\overline{U}_w} = \left[\frac{1-\alpha}{K-\alpha}\right]\left[1 + KC\frac{\sqrt{gD}}{\langle U_w\rangle}\right] \qquad (19)$$

where $\langle U_w\rangle = (1-\alpha)\,\overline{U}_w$ is the superficial liquid velocity.

Equation (18) was used previously, although not derived analytically, by Nicklin et al. (*6*), to correlate results of an experimental slug flow study.

Zuber (*7*) made a more general derivation than that of reference (*4*) by defining a local drift velocity V as

$$V = U_s - U \qquad (20)$$

which is again integrated to obtain the cross-sectional average gas velocity

$$\overline{U}_s = \frac{1}{K}\overline{U} + \frac{\int_A pV\,dA}{\int_A p\,dA} \qquad (21)$$

For slug flow, V is equal to the Taylor rise velocity and Equation (18) is valid. For the bubble flow regimes, Zuber gave other rise velocity rela-

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locus methods, and frequency-response methods. The development is a standard one and, except for some of the examples, is not too different from that found in many electrical engineering texts. The next quarter of the book, however, does apply this linear theory to more complex systems which are of direct interest to the chemical engineer.

The final quarter of the book discusses such nonlinear techniques as phase-plane analysis and the describing-function method and then moves to analog simulation techniques as applied to control systems. This portion of the book is the most interesting; it is unfortunate that a greater percentage of the material covered in the entire book was not devoted to these nonlinear systems.

In general, the book is well written and the examples are clearly detailed. The main drawback is the large amount of linear analysis, but for an undergraduate text this may prove quite valuable.

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Industrial Wastewater Control, C. Fred Gurnham, Editor, Academic Press, New York (1965), 476 pages, $16.00.

Control of water pollution is a subject of high current interest. For several years newspapers and popular magazines have been recounting the ravages of uncontrolled discharge of domestic sewage and industrial wastes into surface water; and public demands for abatement of pollution have been reflected in a great deal of legislative activity at both state and federal levels. Publication of a text and reference work on wastewater control is therefore quite timely.

The editor's introduction defines the various parameters of pollution control and briefly describes the common types of wastewater treatment and management. Each of the contributing authors followed a definite outline consisting of a broad review of his industry, a description of the characteristics and volume of the resulting waste water, a discussion of wastewater treatment processes, and a projection of trends in water quality management. This procedure avoided all needless repetition.

Each of the twenty-four chapters has a brief preface that refers the reader to related material in other chapters. The chapters, which are arranged in logical groups, are: Meat; Fish and Fish Products; Poultry and Eggs; Canned Foods; Starch and Starch Products; Sugar; Fermentation Products; Coal Mining; Metal Mining; Industrial Mineral Mining; Coke and Gas; Iron and Steel; Nonferrous Metals; Petroleum; Inorganic Chemicals; Organic Chemicals; Metal Finishing Products; Pulp and Paper; Textiles; Leather; Power; Atomic Energy; and Transportation.

The authors have assembled a surprisingly large amount of numerical data that are frequently difficult to locate. Thus this is truly a reference work that will be useful equally to the professional consultant and to the plant manager seeking a solution to his own wastewater problem.

There is a single thread that runs through all the chapters: the emphasis on good housekeeping practices and process changes to reduce or eliminate industrial wastes at their sources. These common-sense expedients are sometimes difficult to achieve in old industrial plants, but new installations have provision for wastewater control built into the design.

This book illustrates the great progress industry has made in pollution abatement, but it shows clearly that much more needs to be accomplished and indicates the direction future developments should take. On the other hand, the complex technical and economic problems that must be overcome are well documented.

The literary style of the contributors is attractive and quite uniform, indicating conscientious editorial supervision. There is a good index.

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ERRATUM

In the papers "Vapor-Liquid Equilibria in Hydrogen-Benzene and Hydrogen-Cyclohexane Mixtures" by Richard E. Thompson and Wayne C. Edmister and "Calorimetric Determination of the Isothermal Pressure Effect on the Enthalpy of the Propane-Benzene System" by Lyman Yarborough and Wayne C. Edmister (Vol. 11, No. 3, pp. 457-461 and 492-497, respectively), the captions for Figures 1 and 2 were interchanged. The caption for Figure 1 on page 457 should be interchanged with that for Figure 1 on page 492 and the caption for Figure 2 on page 458 should be interchanged with that for Figure 2 on page 493.