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BOOK REVIEWS

Gas–Liquid–Solid Reactor Design. By Y. T. SHAH. McGraw-Hill, New York, 1979. $44.00.

Two-phase chemical reactions (e.g., gas–solid catalytic reactions) are routinely encountered in all catalysis laboratories, and the design of appropriate chemical reactors is considered basic to the training of catalytic chemists and engineers. Yet, with the growing importance of three-phase chemical reactions (e.g., catalytic hydrodesulfurization, Fischer–Tropsch synthesis), an increasing number of researchers in the catalysis community are now conducting fundamental studies of these reactions. These people, and in particular those who now anticipate initiating catalysis research in three-phase chemical reactions, will find the monograph by Y. T. Shah to be a handy guide to the selection and design of suitable chemical reactors.

The reader of this monograph should not expect to find a pedagogical treatment of three-phase reactor design. Instead, the book has been written as an extensive review of the literature in this field. This literature guide, however, has been made useful to the novice in three-phase reactor design through the use of "recommendation sections" throughout the text. Specifically, after summarizing the recent (and sometimes conflicting) literature dealing with a certain aspect of three-phase reactor design, the author presents his recommendations for the most useful models and correlations to be used. He also points out where appropriate experimental data or theoretical understanding are lacking. The readability of the text is further increased by the inclusion of complete nomenclature lists and illustrative examples at the end of each chapter.

Chapter 1 summarizes the important design parameters for three-phase chemical reactors. Several extensive tables are also contained in this chapter which give examples of different three-phase chemical reactions, and compare and contrast different types of three-phase reactors. The use of film and penetration theories for the analysis of gas–liquid–solid reactions is discussed in Chapter 2. With a minimum of mathematics, the relevant results for "slow, fast, and instantaneous" chemical reactions are presented, and concentration profiles in both the gas and liquid phases are sketched for the various cases. Chapter 3 contains a review of residence time distribution studies of three-phase reactors. the author discusses techniques for both measuring the residence time distribution and modeling the data so obtained. Then, in Chapter 4, the actual reactor modeling for three-phase chemical reactions is discussed. The effects of liquid holdup and effective catalyst wetting are presented and compared. Nonisothermal trickle-bed reactors, three-phase slurry reactors, and packed-bubble-column gas–liquid reactors are considered in detail. However, while Chapter 3 contains a number of models for residence time distributions, it is only the axial-dispersion model that is considered in the reactor models of Chapter 4. The author points out that more sophisticated residence time distribution models do not seem to be justified at present to describe the available experimental data from three-phase reactors. Various types of laboratory reactors for three-phase reactions are subsequently described in Chapter 5. A sketch of each reactor is provided, and the key features of each reactor are summarized in tabular form.

The remaining chapters of the monograph (Chapters 6–9) deal with the estimation of design parameters for gas–liquid–solid reactors. Empirical and theoretical correlations are presented in these chapters for (i) flow regimes, (ii) pressure drop, (iii) gas and liquid holdups, (iv) catalyst wetting, (v) axial dispersion, (vi) gas–liquid mass transfer, (vii) liquid–solid mass transfer, and (viii) heat transfer coefficients. In particular, Chapter 6 deals with cocurrent-downflow fixed-bed reactors; Chapter 7 gives these correlations for cocurrent-upflow fixed-bed reactors; Chapter 8 is concerned with countercurrent-flow fixed-bed reactors; and, Chapter 9 contains this information for gas–liquid suspended-solid reactors.

In short, the monograph "Gas–Liquid–Solid Reactor Design" is a handy guide to the recent literature (up through ca. 1976) on three-phase chemical reaction engineering. The text contains basic principles and empirical correlations, combined with expert comment. As such, it should be useful for both the novice and the expert in this field.

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