tion may be used. The fourth reaction involves combustion of the carbon to carbon dioxide. Complete combustion of other product gases also occurs in the presence of oxygen at these temperatures. The equilibrium constants for these reactions are very large; similarly, rate data which was presented in class indicated that the rate constants for reactions between carbon and oxygen were very large. The fourth reaction might be excluded from consideration since the presence of excess oxygen at specific regions in the bed would likely lead to complete combustion products. The heat derived from such reactions, of course, is necessary to balance the endothermic reactions involved in the production of high Btu gas.

The composition of the product gas may be determined by thermodynamic calculations. At 700 K, the equilibrium constants are $K_1 = 22.6$, $K_2 = 1.60 \times 10^{-3}$ and $K_3 = 7.31$. The corresponding gas phase composition is $y_{CH_4} = 0.20$, $y_{H_2O} = 0.44$, $y_{CO_2} = 0.25$, $y_{H_2} = 0.094$, and $y_{CO} = 0.0074$.

The results of the calculation indicate that the heat required due to the overall endothermic nature of the gasification reactions is relatively low. Substantial amounts of energy are required to heat the coal to 700 K and vaporize the moisture in the coal bed. Students are also capable of providing a rough estimate of the heat loss to the surrounding environment. The effect of approximating the coal composition is relatively small. The results of the calculations vary as a result of the particular assumptions made, but roughly 15-20% of the coal would have to be burned. □

BOOK REVIEW: PROCESS CONTROL

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curious mixture of brevity and detail. A great deal of straightforward algebraic detail is given in many places while in others mastery of far more difficult concepts is assumed. For example, knowledge of eigenvalues and eigenvectors of matrices is assumed in the earlier part of Chapter 3, but is reviewed in some detail later in the same chapter. Far more background in stochastic processes is assumed than the typical chemical engineer has. Although little theory of stochastic processes is actually needed, the jargon is used extensively. The reader is not given enough background for even a clear physical interpretation of the results. Such a commonly used concept as the expected value of a stochastic variable is never even defined. Notation is also a problem in places, with the same symbols being used for different quantities or different symbols used for the same quantities within the same chapter.

In spite of some shortcomings Ray's latest book is highly recommended. It is by far the best book available for a graduate-level level course in modern chemical process control. □

DESIGN OF INDUSTRIAL CHEMICAL REACTORS FROM LABORATORY DATA

By J. Horak & J. Pasek
Heyden & Son, Philadelphia, PA

Reviewed by Moin Ahmed
Union Carbide Corporation

This book is an addition to a large number of books on the design of chemical reactors. However, this book differs from many other text books by emphasizing the practical aspects, sometimes at the expense of needed theory. The book touches some subjects like analytical methods and statistical methods of data evaluation which most books on reactor design do not address.

The book delves into useful qualitative discussion of many design principles, design methods and reactor descriptions. However, in a number of places a more mathematical and less empirical approach would have been useful. Most of the examples are of a qualitative nature, and there are very few examples which emphasize more than one principle at a time. At least on one occasion the book is misleading, referring to free energy of reaction as enthalpy of reaction. The translator has often used terms that are not familiar to American readers (like technological properties of a reactor).

The book is not well organized and is divided into too few chapters. After an introductory chapter, there is a chapter on Reactions in Solutions which is actually a chapter on homogeneous reactions. This chapter is followed by a chapter titled, Types of Reactors. In addition to the title, it describes data collection, treatment and regression of data, determination of specific heats and heats of reaction, and a very good description of scale-up techniques referred to by the authors as Data Transfer. Chapter 4 deals with the catalytic reactors. This chapter also presents the trickle bed reactors, heat transfer media and construction of heat transfer loops—subjects very useful to practicing which are neglected by most reactor design books. On the other hand, the authors have barely touched upon catalyst deactivation, and the discussion of intra particle diffusion limitation and multiplicity in catalyst pellets is very limited. The fifth and the last chapter is on Gas-Liquid and Liquid-Liquid Reaction. The material in this chapter is better presented than in most other books and is very useful to the design engineers.

The authors have completely neglected non-catalyzed gas-solid reactions and a very common class of reactors, namely slurry reactors.

The book can be useful as a reference book for chemical engineers in industry but its utility as an undergraduate or a graduate text seems very limited. This is due not only to the lack of mathematical approach but also because it contains no problems for students to solve. Finally, the book does not represent the state of the art since most of the references are pre-1975. ☐

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in 1973 and 1980; and Pieter Stroeve and Dewey Ryu, are the most recent additions.

While Joe has always emphasized to his colleagues that undergraduate education is a vital part of the UC Davis chemical engineering program, he has also promoted the ideal of strong and varied graduate training. Although Joe is planning a partial retirement to begin in the fall of 1984, he expects to continue to teach and work with graduate students and postdoctoral scholars on chemical engineering research. In view of the personal characteristics he has so far exhibited, it is not anticipated that Joe will retire to a life of leisure and abandon. His single-minded pursuit of achievement in solving chemical engineering problems is probably the critical factor in Joe's success. Undoubtedly, the robust creativity and inexhaustible energy have been important ingredients as well, but his exacting commitment to getting the job done and done well has made the difference between routine and monumental accomplishment.

In all the aspects of chemical engineering education—exemplary research, the writing of textbooks, teaching classes, the guiding of students (graduate and undergraduate) in their research, and administration—Joe Smith has earned and will continue to deserve his Davis title, "Mr. Chemical Engineering". ☐

DIGITAL CONTROL EXPERIMENT

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tive control (k_c = 3.53 volt/volt, τ_D = 0.1 seconds), and proportional-integral-derivative control (k_c = 3.53, τ_I = 20, τ_D = 0.1). Introduction of integral action eliminates the offset (at much longer time than shown in the graph), and less oscillation is shown with P-I-D control.

Fig. 5 represents the effect of sampling time on the system with only proportional control action.

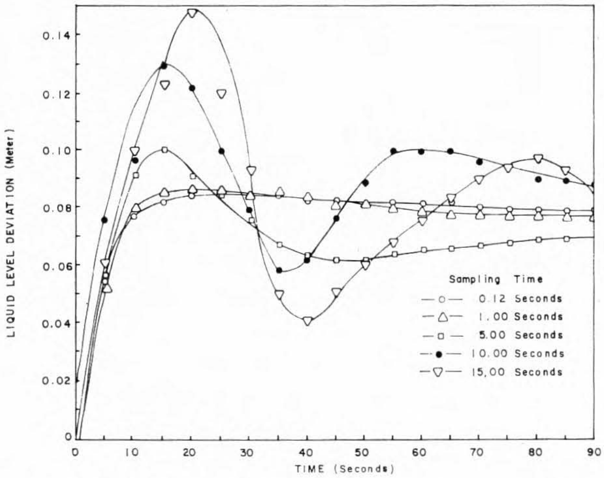

FIGURE 5. Effect of sampling time on system with proportional control.

Increasing the sampling time resulted in higher overshoot and more oscillation. What is interesting is that the system which is first order starts to act like a second order system with decreasing damping coefficient as the sampling time increases. Similar responses are obtained for P-I and P-I-D control.

It should be pointed out that the present undergraduate process control course at NJIT does not cover direct digital control. With this experiment, and the introduction of z-transforms, students can get a very good understanding of discrete sampling and direct digital control. ☐

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