plex (but poorly known) kinetics? Consider baking a potato. *Bon Appetit!*

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ChE **book review**

CHEMICAL PROCESS SAFETY: FUNDAMENTALS WITH APPLICATIONS

by Daniel A. Crowl and Joseph F. Louvar
Prentice-Hall, Englewood Cliffs, NJ 07632; 426+ pages, $49.00 (1990)

Reviewed by
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One of the areas of study frequently missing from the chemical engineer's undergraduate education in the United States is safety and loss prevention. It also happens that safety is one of the areas that practicing engineers all need to have in their repertoire. *Chemical Process Safety* is the first text designed for undergraduate study, and its message can be incorporated into the curriculum by faculty who do not have any specialized background in safety. I have used it as the text for classes in chemical process safety and find it to be an excellent basis for such a course. Like any other teacher, I have incorporated other material into my course and provided a background flavored by my own experience, but that in no way detracts from the text.

Chapter 1 introduces the subject with some statistics and a little background on relative risks and our perception of them. That seems particularly important because we seldom hear the word "chemical" in the news without an adjective like *hazardous* or *dangerous* preceding it. There is also a summary of three significant accidents: the cyclohexane explosion at Flixborough, England; the methyl isocyanate release at Bhopal, India; and the 2, 3, 7, 8-tetrachlorodibenzoparadioxin release at Sevesco, Italy.

Chapter 2 provides a brief background in toxicology. It covers the importance of dose versus response, and details the routes of entry into the body for toxic materials. The definitions for various traditional and legal values of exposure levels are provided, along with a brief background in the analysis of probability curves for assessing response. Probit analysis is shown to be useful for interpolating (and sometimes extrapolating) toxicology data.

Industrial hygiene is covered in Chapter 3. Methods of estimating exposure are presented and some control techniques are discussed. There are some inconsistencies in some of the methods described (for example, vapor emission during drum filling assumes that the air space in a drum is saturated with vapor, but a calculation is still made for the evaporation rate from the liquid surface), but the methods presented are useful for preliminary estimates of ventilation requirements.

Chapter 4 is a review of source models used to estimate the input rates for atmospheric dispersion models. It is primarily a review of fluid mechanics because most source models presume the release originates at a broken pipe or from an orifice in a pipe or vessel. Liquid, compressible fluid, and two-phase fluid flow are all considered, as are vaporization rates from open liquid pools. These methods provide realistic source rates providing the orifice can be well characterized.

The fifth chapter uses the source rates to determine the size of plume that might be formed by a leaking gas or by a vapor from a volatile liquid spill. The dispersion models presented are far from the most sophisticated models available today, but they are appropriate for the level of understanding of students with little or no knowledge in dispersion. They provide a basic understanding of the process and methods used for estimation of the extent of potential danger for toxic or flammable vapors following a release.

Chapter 6 begins the discussion of fires and explosions. The flammability characteristics of liquids and vapors are presented, including the fundamental concepts of flammability limits, minimum oxygen concentration, and flash point. The often-overlooked area of dust explosions is covered in detail, including a description of the equipment used for testing dusts for explosion potential. Methods for estimating the potential for damage from explosions, based on the idea of TNT equivalence, are discussed.

Once the potential for explosions and fires has been presented, methods are discussed for preventing them. Chapter 7 discusses inerting and purging, static electricity and its control, explosion-proof equipment, and ventilation as methods of prevention of fires and explosions. The section on static electricity and its control seems particularly hard for students to grasp, partly because it is so highly summarized and partly because it is foreign to chemical engineers. However, static electricity is important to cover because it is not well understood by chemical engineers and because prevention of static buildup is essential to plant safety.

Chapters 8 and 9 cover the design of relief systems. They include not only the philosophy behind relief systems, but also methods of determining relief sizes. Methods are included for liquids, gases, and two-phase flow. Simplified methods using DIERS results for venting reacting systems are presented, along with the latest NFPA methods for deflagration venting.

Hazard identification and safety reviews are presented in Chapter 10. The quantitative assessment of risk, using probability analysis and fault trees is covered in Chapter 11. These relatively simple procedures are valuable in identifying and correcting potential safety problems in plants, but are seldom covered in undergraduate courses.

The text concludes with chapters on accident investigations (Chapter 12) and case histories (Chapter 13). These are particularly useful to the teacher who does not have a broad background in safety because they provide some real-life illustrations of determining what went wrong,

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ChE **book review**

PROCESS SYSTEMS ANALYSIS AND CONTROL, *2nd edition*

by D. Coughanowr
McGraw-Hill, 1221 Avenue of the Americas, New York, NY 10020; $52.95 (1991)

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I learned process concepts from the first edition of this book when I was a student at the University of Arkansas. The clarity of its presentation and the effectiveness of the instructor (Carl Griffis) have been the main reasons for my sustained interest in process control for the last twenty years.

Much of the material from the first edition has been retained in the second edition, but there are additional new chapters on advanced control strategies, process identification, sampled-data control, state-space representation, multivariable control, and computers in process control applications.

In advanced control, Professor Coughanowr covers cascade and feedforward control, ratio control, dead-time compensation, and internal model control. In the chapters on sampled-data systems the author discusses sampling operations, Z-transforms, design of sampled data controllers, and stability. The chapter on state space method is a good introduction to the subject, as is the chapter on multivariable control.

In the chapter on computer simulation, the author discusses the use of TUTSIM and its potential applications to process control problems. TUTSIM uses an analog computing type of logic and is easy to learn and use. In the last chapter the student is introduced to distributed control concepts. The new material is well written and clear. However, in many instances the level of detail is so small that it is not of much practical use. (But, in a first course in process control, how many topics can be covered?) Also, there does not appear to be enough examples and problems in some of the chapters.

Having made a phenomenal impact on improving quality (and therefore competitiveness) in discrete manufacturing industries, Statistical Quality Control (SQC) concepts have arrived on the scene in continuous industries as well. Statisticians are routinely consulted on issues of quality, but the control engineer is on the sidelines, often unable to make an impact on process operations. Control technologies which can be shown to have a direct impact on quality are needed. This text, as well as others on the market (including ours), does not appear to provide these perspectives to the student.

In closing, the second edition is a good addition to the collection of textbooks on undergraduate process control, subject to the comments in this review. Students and instructors alike will enjoy learning and teaching from this book. ❐

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how it might have been avoided, and how it can be prevented in the future.

There are sample problems throughout the text, and each chapter has problems and questions at the end. Most of the sample problems are clear and easily followed. A manual containing solutions for most of the problems is available. A few of the solutions are incorrect, but the errors are mostly minor and easily found. There are some errors in printing, again mostly minor, and mostly identified in an errata list available from the authors. The errors distract little from the presentation of the material.

I find the text to be a welcome addition; it presents more than enough material for an undergraduate course in chemical process safety. It contains sufficient references that considerable additional material can be found, either for incorporation by the instructor or for additional study by the student. The book can also serve the practicing engineer by providing a basic background for understanding other information that is available. The most important accomplishment of the text may be that it provides the basis for including the study of chemical process safety in the curriculum for chemical engineers. That is something we need to have emphasized more strongly if we are to be professionally competent. ❐