Books

Handbook Of Storage Tank Systems: Codes, Regulations, and Designs, 1st Edition

Edited by Wayne B. Geyer
Marcel Dekker, Inc., New York, 347 pp., indexed, $150, 2000

Storage tanks for flammable and combustible liquids are among the most ubiquitous items of process equipment found in the chemical process industries, as well as in nonprocess facilities (*e.g.*, gasoline stations, etc.). They are designed according to standards from a number of technical organizations, such as ASME International, the American Petroleum Institute (API),Underwriters Laboratories, Inc. (UL), Underwriters Laboratories of Canada (ULC), and the Steel Tank Institute (STI). Tanks are installed as underground or aboveground structures. This handbook reflects the contribution of 20 experts in standards, manufacturing, installation, and specifications of storage tank systems. The book is divided into three main sections: shop-fabricated tanks, underground storage tanks (USTs), and aboveground storage tanks (ASTs), and contains 24 chapters, an appendix, and a good subject index.

Section I on shop-fabricated tanks has seven chapters. The first five are rather short, but informative, covering the history of storage tank systems, historical perspective on standards and codes, history of the uniform fire code, quality control on USTs and ASTs, and UST and AST fabrication. Chapter 6 is a thorough discussion of storage tank specification considerations, covering many topics that should be included in a good tank specification. In Chapter 7, the author discusses the technology decisions that govern whether a tank should be buried (UST) or not (AST).

Section II has nine chapters discussing various aspects of underground storage tank systems. Chapter 8 explains wall thickness requirements for UST design. Chapter 9 reviews development of UL standards for UST safety, while in Chapter 10 the author covers the development of ULC standards for underground storage and handling of flammable and combustible liquids. U.S. federal regulatory programs for USTs are reviewed in Chapter 11. It also includes an appendix listing UST regulators (agencies) for all the states and U.S. territories. Chapter 12 is a short description of the various technologies (designs) for steel USTs. Various aspects of UST installation procedures and requirements are succinctly discussed in Chapter 13. In Chapter 14, the author presents information on several surveys and reports on the performance (history of leaks) of USTs. Chapter 15 is a good discussion of corrosion and cathodic protection of USTs. Much useful and practical information is provided. How to specify UST systems equipment is covered in Chapter 16. Among the information included are the following topics: piping (pressurized, suction, vent or vapor recovery, and metallic and nonmetallic), leak detection, spill prevention, overfill prevention, and containment sumps.

The last section is concerned with ASTs. Chapter 17 is a short summary of AST design options, namely UL and STI types. The development of UL standards for AST safety is described in Chapter 18, while the development of ULC standards for aboveground storage and handling of flammable and combustible liquids is covered in Chapter 19. A brief discussion of secondary containment for noninsulated steel AST systems is presented in Chapter 20. In my opinion, this chapter could have contained much more information, or at least some references.

Chapter 21 is a short review of AST environmental regulations in the U.S. This chapter does contain a number of relevant references for further reading. A very good discussion of plan review (siting and layout) and inspection of ASTs is presented in Chapter 22. Among the many useful topics covered are: land use regulations, tank selection, access and water supply, tank foundations, secondary containment, AST siting requirements, tank vents (normal and emergency), overfill protection systems, liquid piping, electrical equipment, liquid pumps, liquid dispensers, protecting the tank from damage, acceptance inspection, and maintenance inspection. Illustrative calculations for several of the topics are very helpful.

The installation of ASTs is briefly discussed in Chapter 23. Some useful diagrams show pump suction and tank fill methods. The final chapter discusses how to specify AST system equipment, such as filling and dispensing piping, and tank venting system equipment, as well as the applicable legal requirements. The appendix is a compilation of various relevant U.S. EPA and OSHA regulations, codes, standards, and recommended practices applicable for both USTs and ASTs. It also contains names, addresses, telephone and fax numbers, and Web sites for various organizations that deal with UST and AST aspects.

Some of the material in this book could have been more fully discussed and more references included, in my opinion. Also, the material is mainly about UL, ULC, and STI type tanks. However, this book is a useful compendium of relevant information pertaining to the design, specification, and installation of USTs and ASTs, and will be helpful to chemical engineers who have to deal with such storage tanks.

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Liquid and Vapor Flows in Porous Bodies: Surface Phenomena Series: Topics in Chemical Engineering, Vol.13

N. V. Churaev
Gordon and Breach Science, Williston, VT, 323 pp., indexed, $120, 2000

This book, an English translation of the author's 1990 Russian text "Physicochemical Mass Transfer Processes in Porous Bodies," provides a wealth of information otherwise hidden from people who do not read Russian. This reviewer recommends it as a valuable reference for understanding the basic ideas of surface phenomena and colloid science. The book provides an encompassing review of the microforces at work in hydrodynamic and diffusion flows of gases, liquids, and films. The author is a professor at the Institute of Physical Chemistry in Moscow, and editor-in-chief of the *Colloid Journal* of the Russian Academy of Sciences.

Osmotic flow is discussed under capillary, electro, and thermal aspects. The flow of wetting films is covered. Vapor flows follow some different laws than gas flows. This is because the vapor is in the presence of the liquid that generates it. Evaporation of liquid from pores is discussed, either a pure liquid or one with dissolved materials. In some cases, drying shrinks the porous material; and that action is explained. The reverse is gone over, that is, wetting and capillary impregnation.

The author, in addressing the flow of fluid through porous materials, points out that we usually consider that flow as viscous. That is, the flow rate is directly proportional to the driving pressure and the inverse of the viscosity of the fluid. However, through small pores, the viscous flows of gases are diluted with Knudsen (diffusion) flow. The smaller the pore, the greater that flow, also called slip flow, for a given driving pressure. Or, when water flows through small pores with hydrophobic surfaces, that flow also slips, and the smaller the pores the greater the slip.

While admitting to the complicated structure of porous materials, the author mentions that investigators, for simplicity, have taken the view that the path of fluid flow through a porous body is via many parallel tubes of different diameters. He then presents equations relating the increasing amounts of slip flow to decreasing pore diameters. But, the unknown in all this is the distribution of those diameters, and even how we would address a distribution where a fluid flow does not follow straight-through paths. For example, as other writers point out, many porous materials have smaller pores on one face than the other, in which case the meaning of an averaged-size pore through the mass becomes complicated.

Yet, as other writers also mention, we can address, with confidence, the pore-size distribution in a thin layer of a porous material built from a random array of solids. (Here, thin means that a pore goes straight though — we can see through from one side to the other.) Defining pore diameter as the ratio of the cross-sectional area to perimeter, we find that the ratio of the standard deviation of pore diameters to the mean diameter is fixed, no matter what the value of the mean (following the gamma distribution). Then, of course, we must consider three different kinds of means: (1) the number-averaged, (2) the greater, volume-averaged (considering unit thickness of the cross-sectional opening of a pore), and (3) the even greater, viscous-flow-averaged pore diameter.

The next thin layer, if it has the same porosity as the first (*i.e.*, same ratio of void volume to bulk volume), will have the same mean pore diameter and distribution. However, a large pore in the first layer may not necessarily lay over a large pore in the second layer. We thus realize the complications of describing pore-size distributions encountered by fluids passing through porous materials.

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Heat Exchangers: A Practical Approach to Mechanical Construction, Design and Calculations

M. Podhorsky and H. Krips
Begell House, New York, 215 pp., $84.50, 1998

This uncommon book addresses several issues in the mechanical design of shell-and-tube heat exchangers in considerable detail. The authors have restricted the scope of the book to only those topics where they can offer their readers the latest information gained through practical experience. Although the approach is based principally on the German codes and standards, it frequently refers to and provides comparison with the ASME Code, which may be extremely valuable to many readers.

It is well known that standards such as ASME's only specify the minimum requirements for the construction of pressure vessels, and it is the designer's responsibility to ensure that the design is optimum in terms of material, fabrication, and operating costs. This is where the present book comes in handy: it provides assistance in understanding and solving the numerous difficulties and questions that surface during the design process.

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The introductory Chapter 1 entitled "Heat Exchangers for Power Stations" describes the many types of heat exchangers that are employed in power plants and their components, such as tubes, shell, water box, drain cooler, and deaerator. It elaborates failure modes such as corrosion, erosion, and stress-corrosion cracking, and suggests ways to prevent them. It also discusses mechanical design features of the water box, drain cooler, shell, feedwater tank, and deaerator. There is a brief description of multistage heaters and the chapter concludes with a discussion of U-tube and straight-tube steam generators.

Chapter 2, "Calculation of Structural Stresses Using the Force Method," explores the fundamental elements that constitute a heat exchanger design. The force method, in which an entire vessel structure is broken down into individual structural components, is one way of determining discontinuity stresses that are ignored by several codes. The authors present mathematical formulations for flat and dished heads, spherical, cylindrical, and conical shells, tubesheets, and rings. A simple example illustrates how the method is applied to a combination of individual elements.

Chapter 3 is titled "How to Calculate Tubesheets." The design of tubesheets is complicated, because they are weakened by numerous tube holes that are invariably distributed unsymmetrically. This chapter addresses some specific issues in the design of tubesheets.

In Chapter 4, "Design of Flanges for Pressure Vessels," the authors address the design of gasketed, bolted, flanged joints, which is a rather complex affair. The design codes are sometimes simplified in a technically inappropriate manner. In their pioneering approach, the authors address the problem as a complex mechanical assembly that includes the gasket as a full-fledged mechanical element. Their analysis covers not only flange design, but also flange installation as well, because the two are linked inextricably. The various topics covered are bolt design, selection of gaskets, dimensioning of flanges according to codes and using the deformation calculation, the restraint diagram (graph of the individual forces), and causes of possible flange leaks.

Chapter 5 is entitled "Methods of Fastening Tubes in Tubesheets and Headers." It offers an excellent review of the currently used methods for the reliable fastening of tubes in tubesheets, namely welding, roller expansion, hydraulic expansion, and explosion. The authors have enormous experience in the field and have pioneered the hydraulic expansion of tubes into tubesheets, which has become very popular throughout the world due to its superiority.

In the Appendix, a few example calculations are presented. Besides the specific bibliography at the end of each chapter, there is an additional general bibliography in both German and English at the end of the book. Finally, in "Topical References," citations are offered for dished ends, local loads and supports, nozzles, exchanger bellows, and fatigue, again in German and English.

Technically, the book is superb. The 106 figures (diagrams and photographs) are extremely sharp and the layout excellent. The language is easy to understand. With a page size of 175 mm (6.9 in.) × 252 mm (9.9 in.), a font size of 11 points, and a liberal line spacing, the book is very readable. The binding is durable.

The only foible is the absence of an index. In summing up, the book will be a treasure for all those engaged in the mechanical design of heat exchangers and pressure vessels. Highly recommended.

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Environmental Management Systems: A Complete Implementation Guide

Anthony Saponara and Randy A. Roig
Environmental Resources Management, STP Specialty Technical Publishers, Columbia, Canada, 800 pp., $370, 1998

This two-volume set, provided in two three-ring binders with sections separated by labeled tabs, begins with the phrase "ISO 14001 is an opportunity" and an observation that certification about the environment is not easy. It is targeted to facility managers and engineers and presents a systematic approach. The guide includes tools (checklists, task lists, analysis forms, matrices, etc.) and detailed examples and case studies to support preparation for ISO 14001 certification.

The first volume provides an overview of ISO 14001, insights about it, examples of gap analyses and environmental policies, and background for planning including environmental aspects, legal and other requirements, objectives and targets, and management programs. The second volume provides implementation guidance and covers structure and responsibility, training, awareness and competence, communication, documentation, operational control, emergency preparedness and response, corrective action, and management review. Example tools and case studies included in the guide are the ISO 14001 Gap Analysis Tool, Environmental Aspect Identification and Evaluation Procedure, Environmental Aspect Significance Criteria and Rating Scheme, Aspect Significance

Evaluation Matrix, Change Management Checklist, EMS Training Needs Matrix, Document Control Matrix, Records Management Matrix, and a variety of audit and action procedures.

Keys to the value of this implementation guide are items set aside within the text including requirements, audit hints, and core elements for success. Requirements highlight program "musts" by standard clauses. Audit hints suggest things auditors might look for, questions they might ask, etc. The authors also add core elements for success, including reminders to keep things simple and realistic, the identification of the roles of key personnel, matching actions to needs, and so on.

This guide provides a systematic approach to preparing for certification and offers many tools. Tools may, in general, be customized for a particular organization by transposing them into electronic document files. The guide misses the mark on a number of key points: no method is provided to prioritize improvement and corrective/preventive actions or to involve interested parties. In spite of these shortcomings, the guide is a helpful resource for the environmental management systems (EMS) champion(s) within an organization considering certification.

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Analysis of Transport Phenomena

William M. Deen
Oxford University Press, New York, 597 pp., $75, 1998

The Manhattan Project not only produced the weapons that ended the Second World War, but it started a revolution in the engineering sciences. Development of the atomic bombs at Los Alamos was an engineering project, not a scientific project. The design of an atomic bomb and evaluation of its effect involves analyzing the transport of momentum and energy. Acquisition of the material required to build an atomic bomb involves analyzing mass transport. The mathematical analyses and techniques used by the Los Alamos physicists were employed with great effect in the various engineering sciences during the 1950s. It was during this period that "momentum, energy, and mass transport" was recognized as a unified engineering subject. This realization resulted in the ground-breaking presentation of these subjects by Bird, Stewart, and Lightfoot in their "Transport Phenomena."

Professor William Deen's book "Analysis of Transport Phenomena" adds depth to the unified presentation of these subjects by clearly showing the mathematical connection underlying the three transport phenomena.

In Chapter 1, Deen presents diffusive fluxes and material properties. He develops the concept of conservation equations in Chapter 2. Chapter 2 (see Table 2.1) is where the author demonstrates the underlying concepts unifying the three transport phenomena.

The next two chapters provide mathematical reviews for solving transport equations. Scaling and approximation methods are covered in Chapter 3, including perturbation analysis. Chapter 4 presents methods for solving conduction and diffusion problems. This chapter concentrates on the finite Fourier transform method. However, Deen does present Green's functions toward the end of Chapter 4. The use of Green's functions is only going to increase in the future. It is good that Deen introduces chemical engineering students to them now.

The next four chapters discuss various aspects of fluid mechanics. Chapter 5 covers the fundamentals of fluid mechanics. Unidirectional flow and creeping flow are discussed in Chapters 6 and 7, respectively. Laminar flow at high Reynolds number is the subject of Chapter 8.

Two chapters on forced-convection heat and mass transport follow the fluid mechanics section. Chapter 9 covers heat and mass transport in confined laminar flow. Unconfined laminar-flow heat and mass transport are presented in Chapter 10.

Chapter 11 discusses multicomponent energy and mass transport. Deen presents buoyancy-driven flow transport in Chapter 12. Turbulent flow transport is discussed in Chapter 13.

Professor Deen provides eight appendices in his text, all dealing with vector and tensor analysis.

Each important point in each chapter is illustrated with a fully worked example. In many cases, the author provides more than one such example per discussion point. These worked examples are reason enough to possess this book. Of course, Deen includes a wealth of unsolved problems at the end of each chapter.

This book is clearly written with extremely few typos. It was well edited and proofread. It was written for first-year chemical engineering students, but it could also be used by first-year physics and applied mathematics students.

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