Book Review

Pressure Component Construction . . . Design and Materials Application. By John F. Harvey. Van Nostrand Reinhold, New York (Mar. 1980). $24.95.

Pressure Component Construction . . . Design and Materials Application presents a broad compilation of pressure vessel design and fabrication knowledge. The author has drawn on his obviously extensive experience in this field. The nature of the book makes it most valuable as a guide for the practicing engineer. As in any book with broad subject coverage, many of the in-depth discussions must be omitted. However, the author has listed extensive references for more detailed study on specific topics.

The first four chapters deal with design philosophy and stress analysis. The introductory chapter presents an elementary view of stress, strain, experimental methods, and design philosophy. A chapter on stresses in pressure vessels presents the analysis of many typical vessel configurations and their relation to vessel design. Membrane stress analyses are developed for spherical, cylindrical, intersecting spheres, and toroidal geometries. Thick spheres and cylinders are treated. Thermal stresses in thick cylinders are also developed. A chapter for stresses in flat plates deals with flat plates as they are used in vessel closures and other vessel components. Topics covered are

1. bending of circular plates with uniform loading, central loading, or concentric loading
2. circular plates with central holes or rigid inserts
3. circular plates reinforced with grillage or rings
4. flat perforated sheets.

Chapter 4 treats discontinuity stresses developed at junctions of dissimilar geometries or materials. Stresses in vessel head to cylinder junctions, bimetallic cylinder welded joints, and cylinder flanges are developed by traditional beam on elastic foundation methods. These first four chapters serve mainly to pull together the commonly used body of knowledge on pressure vessel design and analysis.

The remaining three chapters address the more practical construction and design problems including materials, construction feature design, and economics. The chapter on materials is devoted to pressure vessel steels. The common material properties are discussed along with effects of neutron irradiation. Fatigue is discussed in considerable detail (47 pp.) for this type of book. Other topics include creep, hydrogen embrittlement, and a design approach to fracture mechanics. There are 283 references listed at the end of this chapter. The chapter on design-construction features begins with discussion of theoretical stress concentrations for simple geometries. These are used to develop design equations for more realistic geometries of practical designs. Topical sections study nozzles, welded joints, bolted joints, and nonbolted closures. The author gives an extensive offering of design guidance and insight throughout the chapter. The final chapter is labeled "Economics," but deals primarily with the more uncommon material and construction choices. Fiber-reinforced composite materials and prestressed concrete are discussed in an abbreviated manner. The early technology in these rapidly changing fields is presented and does not significantly contribute to the overall book.

The chapters on materials and design-construction features would be of most use to the engineer engaged in pressure vessel design. A major weakness of the book is the omission of any significant discussion of numerical analysis methods, especially the finite element method, and their impact on vessel design. In these times, experimental evaluation is too costly and most designs must be evaluated analytically and redesigned as necessary before any significant experimental evaluation begins.

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About the Reviewer: Charles Knight is an associate professor of mechanical engineering at the Virginia Polytechnic Institute and State University, an association begun in 1980 following an extended experience with the Union Carbide Corporation in Oak Ridge. In the latter, his assignments included the design of composite pressure vessels and flywheels, and the application of finite element stress analysis. Dr. Knight's academic training was at Tennessee Tech and the University of Tennessee.