Foreword viii
by John J. McKetta

Preface to the Second Edition ix

Chapter 1
Piping Fluid Mechanics 1

Basic Equations, 1
Non-Newtonian Fluids, 5
Velocity Heads, 8
Pipe Flow Geometries, 22
Compressible Flow, 25
Piping Fluid Mechanics Problem Formulation, 25
Example 1-1: Friction Pressure Drop for a Hydrocarbon Gas-Steam Mixture in a Pipe, 27
Example 1-2: Frictional Pressure Drop for a Hot Oil System of a Process Tank, 33
Example 1-3: Friction Pressure Drop for a Waste Heat Recovery System, 42
Example 1-4: Pressure Drop in Relief Valve Piping System, 43
Example 1-5: Expressing All Pipe Sizes in Terms of One Diameter, 44
Notation, 46
References, 46

Chapter 2
The Engineering Mechanics of Piping 47

Piping Criteria, 47
Primary and Secondary Stresses, 49
Allowable Stress Range for Secondary Stresses,
Flexibility and Stiffness of Piping Systems, 52
Stiffness Method Advantages. Flexibility Method Advantages.
Stiffness Method and Large Piping, 58
Flexibility Method of Piping Mechanics. Pipe Loops.

Chapter 3
Heat Transfer in Piping and Equipment 102

Jacketed Pipe versus Traced Pipe, 102
Tracing Piping Systems, 104
Condensate Return. Maximum Length of Steam Tracers.
Heat Transfer in Residual Systems, 132
Condensate Return through Cylindrical Shells.
Residual Heat Transfer through Pipe Shoes.
Example 3-1: Steam Tracing Design, 136
Example 3-2: Hot Oil Tracing Design, 137
Example 3-3: Jacketed Pipe Design, 139
Example 3-4: Thermal Evaluation of a Process Tank, 141
Example 3-5: Thermal Design of a Process Tank, 142
Internal Baffle Plates Film Coefficient. Film Coefficient External to Baffles—Forced

**Example 3-6:** Transient and Static Heat Transfer Design, 148

**Example 3-7:** Heat Transfer through Vessel Skirts, 152

**Example 3-8:** Residual Heat Transfer, 154

**Example 3-9:** Heat Transfer through Pipe Shoe, 156

Notation, 156
References, 157

**Chapter 4**

**The Engineering Mechanics of Pressure Vessels** .......................... 159

Designing for Internal Pressure, 159
Designing for External Pressure, 160
Design of Horizontal Pressure Vessels, 166
Steel Saddle Plate Design, 174
Saddle Bearing Plate Thickness, 180
Design of Self-Supported Vertical Vessels, 180
Minimum Shell Thickness Required for Combined Loads, 181
Support Skirt Design, 183
Anchor Bolts, 184
Base Plate Thickness Design, 186
Compression Ring and Gusset Plate Design, 189
Anchor Bolt Torque, 189
Wind Analysis of Towers, 190
  Wind Design Speeds. Wind-Induced Moments.
  Wind-Induced Deflections of Towers.
  Wind-Induced Vibrations on Tall Towers.
Seismic Design of Tall Towers, 209
  Vertical Distribution of Shear Forces.
Tower Shell Discontinuities and Conical Sections, 214
**Example 4-1:** Wear Plate Requirement Analysis, 215

**Example 4-2:** Mechanical Design of Process Column, 215

**Example 4-3:** Seismic Analysis of a Vertical Tower, 237
**Example 4-4:** Vibration Analysis for Tower with Large Vortex-Induced Displacements, 241
  Moments of Inertia. Wind Deflections.
**Example 4-5:** Saddle Plate Analysis of a Horizontal Vessel, 249
  Saddle Plate Buckling Analysis. Horizontal Reaction Force on Saddle.
Notation, 252
References, 254

**Appendix A**

**Partial Volumes and Pressure Vessel Calculations** .................. 255
PartialVolumes of Spherically Dished Heads, 256
PartialVolumes of Elliptical Heads, 257
PartialVolumes of Torispherical Heads, 259
Internal Pressure ASME Formulations with Outside Dimensions, 261
Internal Pressure ASME Formulations with Inside Dimensions, 262

**Appendix B**

**National Wind Design Standards** ................. 265
Criteria for Determining Wind Speed, 265
Wind Speed Relationships, 266
ANSI A58.1-1982 Wind Categories, 267

**Appendix C**

**Properties of Pipe** .............................. 271
Insulation Weight Factors, 278
Weights of Piping Materials, 279

**Appendix D**

**Conversion Factors** .................. 303
Alphabetical Conversion Factors, 304
Synchronous Speeds, 311
Temperature Conversion, 312
Altitude and Atmospheric Pressures, 313
Pressure Conversion Chart, 314

**Appendix E**

**Heat Transfer Systems for Vessels and Tanks** .................. 315
Appendix F
Transient Heat Transfer .......................... 337

Appendix G
ASME Code Considerations ......................... 341

Appendix H
Computer Algorithms Written in Microsoft
Quick Basic ............................................. 361

Index ...................................................... 364