620.106 SUL 2d ed.

CONTENTS

FORWARD, vii

PREFACE, viii

1 INTRODUCTION

1-1: Introduction, 1
1-2: Historical Perspective, 2
1-3: Capabilities, 2
1-4: Size of the Industry, 8
1-5: Careers in Fluid Power, 9
1-6: How Fluid Power Works, 12
1-7: Summary, 15

2 BASICS OF HYDRAULICS

2-1: Introduction, 19
2-2: How Oil Transmits Power, 20
2-3: Work Performed by the System, 21
2-4: Multiplication of Force, 21
2-5: Power and Horsepower, 24
2-6: Fluid Horsepower, 26
2-7: Torque and Torque Horsepower, 31
2-8: Torque Horsepower and Fluid Horsepower Relationships, 32
2-9: Summary, 34

3 HYDRAULIC FLUIDS

3-1: Introduction, 37
3-2: Types of Fluids, 38
3-3: Fluid Applications, 40
3-4: Properties of Fluids, 42
3-5: Fluid Storage and Handling, 52
3-6: Filtration, 53
3-7: Summary, 64

4 SEALS AND PACKINGS

4-1: Introduction, 67
4-2: Static Seals, 70
4-3: Dynamic Seals, 76
4-4: Materials and Compounds, 79
4-5: Seal Configuration, 83
4-6: Elastomer Seal Testing, 91
4-7: Summary, 92

5 ENERGY IN HYDRAULIC SYSTEMS

5-1: Introduction, 95
5-2: Continuity Equation, 96
5-3: Pressure and Head, 100
5-4: Potential and Kinetic Energy, 103
5-5: Bernoulli's Equation, 106
5-6: Torricelli's Theorem, 110
5-7: Flow Through Orifices, 112
5-8: Flow in Pipes, 114
5-9: Reynolds Number, 115
5-10: Darcy-Weisbach and Hagen Poiseuille Formulas, 118
5-11: Equivalent Length, 124
5-12: Circuit Calculations, 126
5-13: Summary, 130

6 PUMPS

6-1: Introduction, 133
6-2: Pumping Theory, 134
6-3: Pump Types, 140
6-4: Pump Performance, 160
6-5: Pump Selection Factors, 163
6-6: Other Pump Characteristics, 164
6-7: Summary, 166

7 VALVES

7-1: Introduction, 171
7-2: Pressure Control Valves, 173
7-3: Flow Control Valves, 176
7-4: Directional Control Valves, 183
7-5: Summary, 205

8 ACTUATORS: CYLINDERS AND MOTORS

8-1: Introduction, 207
8-2: Cylinders, 208
8-3: Cushioning Devices, 217
8-4: Rotary Actuators, 227
8-5: Limited Rotation Actuators, 232
8-6: Continuous Rotation Actuators, 234
8-7: Electrohydraulic Pulse Motors (EHPM), 243
8-8: Output Performance and Testing, 245
8-9: Summary, 248

9 SYSTEMS COMPONENTS

9-1: Introduction, 251
9-2: Reservoirs and Heat Exchangers, 252
9-3: Accumulators, 258
9-4: Intensifiers, 264
9-5: Conductors and Connectors, 267
9-6: Instrumentation, 278
9-7: Hydraulic Power Units, 282
9-8: Hydrostatic Transmissions, 284
9-9: Electrical Controls, 287
9-10: Summary, 292

10 SYSTEMS DESIGN AND BASIC CIRCUITS

10-1: Introduction, 295
10-2: Sizing Actuators from Output Objectives, 297
10-3: Constant Flow Systems, 304
10-4: Constant Pressure Systems (C-P), 306
10-5: Constant Horsepower Systems (C-Hp), 307
10-6: Load Sensing Systems, 310
10-7: Basic Circuits, 312
10-8: Open Center vs. Closed Center Circuits, 322
10-9: Pump Selection, 325
10-10: Matching Components, 327
10-11: Monitoring Performance, 328
10-12: Compliance with Safety Recommendations and Standards, 330
10-13: Summary, 332

11 INTRODUCTION TO PNEUMATICS

11-1: Introduction, 335
11-2: Applying Gas Laws to Pneumatic Systems, 336
11-3: Compressors, 342
11-4: Pneumatic Systems, 349
11-5: Valves, 354
11-6: Cylinders and Motors, 362
11-7: Air Conditioners, 364
11-8: Basic Circuits, 371
11-9: Summary, 376

12 PNEUMATIC LOGIC CONTROL

12-1: Introduction, 379
12-2: Logic Control Concepts, 380
12-3: Basic Air Logic Circuit Design, 385
12-4: Miniature Pneumatics, 386
12-5: Moving Part Logic and Modular Air Components, 387
12-6: Fluidic Control Systems, 389
12-7: Operating Principles, 390
12-8: Fluidic Devices, 394
12-9: Basic Fluidic Circuits, 398
12-10: Summary, 402

APPENDIX A
LETTER SYMBOLS AND ABBREVIATIONS, **404**

APPENDIX B
CONVERSION FACTORS, **408**

APPENDIX C
APPROXIMATE VISCOSITY CONVERSIONS, **409**

APPENDIX D
USA STANDARD GRAPHIC SYMBOLS FOR FLUID POWER DIAGRAMS, **411**

APPENDIX E
OFFSET BEND CALCULATIONS FOR STEEL TUBING, **423**

APPENDIX F
STANDARD TEST PROCEDURES, **427**

INDEX, 432