CONTENTS

Preface x

Chapter 1 VACUUM SYSTEM ENGINEERING AND KINETIC TH	HEORY 1
1-1 Early History	1
1-2 Vacuum Defined	9
1-3 Kinetic Theory	10
1-4 Ideal Gas Laws	13
1-5 Deviations from Ideality	18
Chapter 2 FLUID FLOW IN VACUUM LINES	21
2-1 Flow Regimes	22
2-2 Viscosity	25
2-3 Viscous Flow	29
2-4 Transitional and Molecular Flow	40
Chapter 3 PRESSURE MEASUREMENT	49
3-1 Units of Pressure Measurement	49
3-2 Vacuum Gauge Selection	51
3-3 Vacuum Gauges	53
3-4 Calibration and Installation of Vacuum Gauges	71
3-5 Use of Vacuum Gauges in Troubleshooting	/4
Chapter 4 AIR LEAKAGE	76
	76
4-1 Rough Vacuum	84
4-2 Medium and High Vacuum 4-3 Leaks and Leak Testing	87
4-4 Component Design	98
positio beargn	

vii

10-1 Principles of Operation 10-2 Pump Selection and Rating 10-3 Pump Specifications 10-4 Special Applications	Chapter 10 LIQUID RING VACUUM PUMPS	9-1 Ejector Design 9-2 Operating Principle 9-3 Specification of Steam Jets 9-4 Motive Steam Requirements 9-5 Alternatives to Steam 9-6 Purchase Cost	Chapter 9 STEAM JET EJECTORS	 8-1 Suction Pressure and Capacity 8-2 Reliability and Maintenance 8-3 Purchase and Installation Costs 8-4 Operating Costs 8-5 Environmental Considerations 	Chapter 8 SELECTING THE VACUUM PUMP	7-1 When to Use a Precondenser 7-2 Determining Vapor Loads 7-3 Direct-Contact Condensers 7-4 Surface Condensers 7-5 Condenser Purchase Costs 7-6 Use of Refrigeration	Chapter 7 PRECONDENSERS	6-1 Refrigeration 6-2 Evaporation and Crystallization 6-3 Filtration 6-4 Drying 6-5 Freeze Drying	Shapter 6 PROCESS APPLICATIONS II	apter 5 PROCESS APPLICATIONS I 5-1 Distillation 5-2 Molecular Distillation 5-3 Degassing 5-4 Reactions 5-5 Semiconductor Processing
262 269 281 285	261	230 234 237 248 255 258	229	205 211 219 221 226	204	178 181 188 200 201	175	144 154 160 171	138	107 107 121 126 130 133

Index 349	Appendix C GLOSSARY	Appendix B PHYSICAL PROPERTIES	Appendix A SI UNIT CONVERSIONS	12-1 Installation 12-2 Operation 12-3 Maintenance	Chapter 12 INSTALLATION, OPERATION, AND MAINTENANCE	Chapter 11 ROTARY PISTON AND ROTARY VANE PUMPS 11-1 Principles of Operation 11-2 Pump Selection and Rating 11-3 Pump Specifications 11-4 Pumping Condensable Vapors	
	345	342	339	310 324 329	310	287 288 293 298 300	