

Contents

Introduction.....	9
Chapter 1: Refrigeration – basic principles	11
History of refrigeration	11
Scope of the industry	12
Classification of applications	12
Food preservation	16
Refrigerated storage	18
Understanding refrigeration – basic principles	21
Standard refrigeration system	43
The standard refrigeration cycle.....	50
Refrigerants.....	55
Environmental effects of refrigerants.....	62
Refrigerant properties and performance	67
Refrigerants, lubricants and system considerations.....	69
Chapter 2: Refrigeration and air-conditioning compressors	73
Introduction	73
Types of compressor.....	74
Reciprocating (Type 1) compressors	75
Rotary (Type 2) compressors.....	100
Centrifugal (Type 3) compressors	104
Screw (Type 4) compressors	107
Scroll (Type 5) compressors	112
Condensing units	115
Chapter 3: Condensers.....	117
Introduction	117
Air-cooled (Type 1) condensers	118
Water-cooled (Type 2) condensers	132
Evaporative (Type 3) condensers	136
Cooling towers	138
Water treatment.....	142
Water regulating valves.....	142
Over-condensing.....	144
Common faults and testing	144
Chapter 4: Evaporators.....	145
Introduction	145
General classification	146
Types of construction	147
Natural-draught evaporators	150
Forced-draught/induced-draught evaporators.....	153
Liquid-cooling evaporators	157
Contact cooling and freezing plates	163
Water or brine coils	168
Calculations for heat-transfer vessels	168

Chapter 5: Refrigerant controls	181
Introduction – types and function of control devices	181
Hand-operated expansion (needle) valves	182
Low-side float control (LSF)	183
High-side float control (HSF).....	186
Automatic expansion valve (AEV or AXV).....	188
Thermostatic expansion valve (TXV or TX valve).....	190
Thermal-electric expansion valve.....	203
The electronic valve	205
Capillary tube control	207
Chapter 6: Ancillary equipment	215
Introduction	215
Manual shut-off valves	215
Check valves.....	218
Relief valves and fusible plugs.....	219
Valves to control temperature or pressure	220
Pilot or servo-controlled line valves.....	226
Strainers.....	228
Driers.....	228
Sight glass and moisture indicator	229
Heat exchangers	231
Suction line accumulators	231
Surge drum or equaliser tank.....	232
Oil separators.....	234
Discharge mufflers	234
Receivers	235
Vibration eliminators.....	236
Crankcase heaters	237
Liquid pressure amplification (LPA).....	238
Chapter 7: Domestic, commercial and industrial systems.....	243
Introduction	243
Domestic refrigeration	243
Domestic refrigerating systems	243
Freezers	251
Dust accumulation on condensers	252
Installation of domestic refrigerators.....	253
Commercial refrigeration.....	254
Supermarket merchandisers	254
Multi-evaporator systems	265
Multiplexing.....	270
Compressor ‘unloading’ and capacity control.....	273
Commercial defrost controls and accessories.....	282
Industrial systems	287
Multi-stage (booster) compression	287
Liquid recirculation system	290
Liquid return systems	294

Chapter 8: Hand and power tools	295
Introduction	295
Hammers.....	295
Files and filing	296
Hacksaws.....	299
Snips	301
Tools for marking out.....	303
Fasteners etc with vee-form screw threads	304
Taps.....	308
Dies	309
Drill bits	310
Drilling machines.....	318
Off-hand grinding.....	321
Measuring tools.....	325
Chapter 9: Specialised tools	331
Introduction	331
Spanners and wrenches	331
Screwdrivers	333
Pliers	333
Punches	334
Hex key set	334
Tube-working tools and fittings.....	334
Refrigerants.....	347
Charging equipment.....	347
Refrigeration service gauge set, manifold and lines	348
Leak-testing instruments	349
Vacuum pumps.....	352
Thermometers.....	353
Chapter 10: Brazing and welding.....	355
Introduction	355
Oxyacetylene plant.....	355
Safety precautions.....	356
Opening an oxyacetylene plant	357
Welding tip selection.....	357
Flame adjustment	358
Maintenance of nozzles.....	359
Backfires and flashbacks.....	360
Closing down the plant	360
Silver brazing	360
Joint preparation.....	361
Procedure	362
Some tips for silver brazing	365
Heat treatment of metals.....	367
Manual metal arc welding (MMAW)	368
MMAW welding equipment.....	368
Design of electrodes.....	371
Types of covered electrodes.....	373
MMAW welding techniques	374
MMAW welding practices	378

Gas metal arc welding (GMAW).....	382
Introduction.....	382
Principles.....	382
Personal protection.....	384
Equipment.....	385
Metal transfer.....	389
Electrode selection.....	393
Gas metal arc welding variables.....	394
Shielding gases.....	396
Gas metal arc welding defects.....	399
Trouble shooting/equipment malfunction.....	402
Arc welding safety precautions.....	404
Welding, EMF and pacemakers.....	408
Chapter 11: Electrical principles.....	411
Structure of matter.....	411
Movement of electrons.....	412
Electrical terms.....	413
Conductors, semiconductors and insulators.....	415
Ohm's law.....	418
Running costs.....	420
Series and parallel circuits.....	421
Measurement of electrical circuits.....	425
Magnetism.....	429
Production of electricity.....	434
Electronic components.....	444
Chapter 12: Electrical components.....	451
Switches, controls and components.....	451
Overloads.....	462
Capacitors.....	464
Basic circuit.....	466
Transformers.....	469
Contactors and relays.....	470
Fluorescent lighting.....	472
System control.....	473
Proportional control.....	474
Reset control.....	475
Rate action.....	476
Digital control.....	477
Motorised actuators.....	478
Electronic/microprocessor control systems.....	481
Microprocessor-based/DDC fundamentals.....	482
Introduction.....	482
Definitions.....	483
Background.....	483
Advantages.....	485
Controller configuration.....	486
Types of controller.....	487
Controller software.....	488

Controller programming	497
Typical applications	502
Chapter 13: Electrical wiring	505
Earthing	505
Electrical cables	507
Flexible cords	511
Three-pin plugs	514
Circuit protection and isolation	514
Removal of equipment	516
Safety devices	516
Safety measures against electric shock	518
Chapter 14: Electric motors	523
Introduction	523
DC motors	523
AC motors	525
Three-phase motors	534
Three-phase contactors and starters	537
Chapter 15: Electrical testing	549
Circuit testing and repair	549
Voltage of supply systems	553
Testing for electrical safety	555
Other checking/testing instruments	556
Measurement and safety limits	560
Testing electrical components of refrigeration and air-conditioning equipment	560
Testing for electrical faults in refrigeration systems	566
Chapter 16: Measuring and test instruments	575
Introduction	575
Temperature-measuring instruments	575
Temperature measurement	579
Airflow-measuring instruments	583
Measuring pressure	587
Calibration and use of instruments	590
Leak-detecting instruments	595
Noise measurement	597
Glossary	601
Index	623