# PERRY'S CHEMICAL ENGINEERS' HANDBOOK

佩里化学工程师手册

SEVENTH EDITION

(第七版)

Robert H.Perry Don W.Green



# 佩里化学工程师手册 (第七版)

# PERRY'S CHEMICAL ENGINEERS' HANDBOOK

SEVENTH EDITION

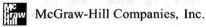
(影印版·下册)

Robert H. Perry

Don W. Green

江苏工业学院图书馆 藏 书 章





ISBN: 7-03-008789-5/TQ·36

图字: 01-2000-2403

Robert H. Perry, Don W. Green: Perry's Chemical Engineers' Handbook,

Seventh Edition

Copyright © 1997 by The McGraw-Hill Companies, Inc.

Authorized Reprinting by Science Press.

All rights reserved. For sale in the People's Republic of China only.

ISBN: 0-07-115982-7

本书英文影印版由科学出版社和美国麦格劳-希尔国际公司合作出版。 未经出版者书面许可,不得以任何方式复制或抄袭本书的任何部分。版权 所有,翻版必究。

### 斜学出版社 出版

北京东黄城根北街 16 号 邮政编码:100717

### 新蕾印刷厂 印刷

科学出版社发行 各地新华书店经销

2001年2月第 一 版 开本: 850×1168 1/16 2001年2月第一次印刷 印张: 165

2001 年 2 月第一次印刷 印张: 165 印数: 1-3 000 字数: 5 820 000

定价: 390.00 元 (上、下册)

(如有印装质量问题,我社负责调换(新欣))

## Index

```
abietic acid, 2-28
                                                          acenaphthene, 2-28
abrasion index, 20-12
                                                          acentric factor, 4-16
absorptance, 5-25 to 5-27
                                                          acetal, 2-28, 2-61
  definition, 5-25
                                                          acetaldehyde, 2-28, 2-52, 2-61
  variation with temperature of radiation source,
                                                          acetaldehyde ammonia, 2-28
                                                          acetamide, 2-28, 2-53, 2-61
accelerating rate calorimeter (ARC), 26-50
                                                          acetanilide, 2-28, 2-61
acceleration:
                                                         acetic acid, 2-28, 2-52, 2-61, 2-110, 2-175, 2-184,
  centrifugal, 18-106
                                                                 2-204
  coriolis, 18-107
                                                         acetic anhydride, 2-28, 2-52
accounting, 9-39 to 9-54
                                                         acetic nitrile, 2-28, 2-53
  accountacy, types of, 9-41
                                                         acetone, 2-28, 2-52, 2-61, 2-175, 2-206
  balance sheets, 9-41
                                                         acetonyl urea, 2-28
  books, closing of, 9-39
                                                         acetophenone benzoyl hydride, 2-28
  budgets, 9-54
                                                         acetphenetidide, 2-28
  capital:
                                                         acettoluidide, 2-28
    concepts, 9-40
                                                         acetyl chloride, 2-28
    conventions, 9-40
                                                         acetylene, 2-28, 2-50, 2-61, 2-125, 2-206
    cost of, 9-47 to 9-48
                                                         acetylene dichloride, 2-28
    cost control, 9-54
                                                         acetyl phenylenediamine, 2-28
    double-entry, 9-39
                                                         acid egg, 10-35
    working, 9-52 to 9-54
                                                         aconitic acid, 2-28
  company data, comparative, 9-45
                                                         acridine, 2-28, 2-61
  equities, purchase and sale of, 9-44
                                                         acrolein ethylene aldehyde, 2-28
  financial ratios, 9-42 to 9-43
                                                         acrylic acid, 2-28, 2-61
  financing debt, 9-44 to 9-45
                                                         acrylic nitrile, 2-28
  financing of assets:
                                                         activity coefficient, 4-25
    by debt, 9-43
                                                         actuators, 8-66 to 8-67
    by equity, 9-43 to 9-44
                                                            diaphragm actuator, 8-66
  income statements, 9-41
                                                            electric, 8-67
  inventory evalution and control, 9-49 to 9-51
                                                            hydraulic, 8-67
  management and cost, 9-48
                                                            motion conversion, 8-67
 overall company ratios, application of, 9-45 to 9-46
                                                            pneumatic, 8-66 to 8-67
 principles of, 9-39
                                                         Adams-Bashforth method, 3-55
 retained earnings, 9-44
                                                         adaptive meshes, 3-60
```

### I.4 INDEX

1.1	advanced control system (Cont.)
adiabatic, 10-5	advanced control system (Cont.):
flow, <b>10-</b> 5	fuzzy logic control, 8-21
adipic acid, 2-28, 2-61	override control, 8-19 to 8-20
adipic amide, 2-28	relative gain array method (RGA), 8-24
adipic nitrile, 2-28	smith preditor, 8-19 to 8-20
adrenaline, 2-28	statistical process control, 8-21
adsorbents:	aerosol deposition:
density:	mechanism, 17-25
bulk, <b>16</b> -11	parameter, 17-25
particle, <b>16</b> -11	affinity laws, 10-25
skeletal, 16-11	agglomeration, <b>19</b> -33, <b>20</b> -56
wet, <b>16</b> -11	agitation, 20-56
See also sorbents	circuit, <b>20</b> -57
adsorption:	compression, 20-56
adiabatic, <b>16</b> -32 to <b>16</b> -34	density, 20-59
batch processes, 16-25 to 16-29	extent of, <b>20-5</b> 7
biochemical separation, 22-75	granulation, 20-57
countercurrent, 16-60 to 16-64	kinetics, 20-57
crosscurrent, <b>16</b> -61 to <b>16</b> -62	porosity, 20-59
cycles, <b>16-</b> 48 to <b>16-</b> 52, <b>16-</b> 54 to <b>16-</b> 56	rate process, <b>20</b> -61 to <b>20</b> -73
pressure swing adsorption (PSA), 16-49 to	breakage, <b>20</b> -68
16-51	growth and consolidation, <b>20</b> -64
-	powder compaction, <b>20</b> -69
purge/concentration swing adsorption, <b>16-51</b>	
to 16-52	wetting, <b>20</b> -61
temperature swing adsorption (TSA), 16-48 to	size, <b>20</b> -59
16-49	strength of, <b>20</b> -60
design concepts, 16-5 to 16-7	agitated vessels, jackets of, 18-23
energy balance, 16-17	agitation, 11-27
equilibrium, 16-5	bed agitation intensity, 20-64
multiple components, 16-15	high agitation intensity, 20-64
separation factor, 16-14 to 16-16	low agitation intensity, 20-64
equipment, 16-56	agitation equipment, 18-12 to 18-13
controls, 16-59	selection of, 18-12
regeneration, <b>16</b> -58 to <b>16</b> -59	air, <b>2</b> -53, <b>2</b> -125, <b>2</b> -133, <b>2</b> -140, <b>2</b> -200, <b>2</b> -207 to
vessels, <b>16</b> -56 to <b>16</b> -58	<b>2</b> -214, <b>2</b> -221
fixed beds. See fixed beds	air conditioning, 11-74 to 11-76
heat transfer in, 16-18	application of, 11-74
isotherms. See isotherms	definition of, 11-74
mass transfer in. See mass transfer	equipment for, 11-74
material balance, 16-17	air-cooled:
moving beds, simulated, 16-56, 16-63 to 16-64	heat exchanger, 11-47 to 11-52
physical properties of, 16-9	air-flow control, 11-50
process selection, 16-56	air recirculation, 11-50
rate factor, 16-17	costs of, table, 11-51
selection of, 16-5 to 16-6	evaporative cooling, 11-50
adsorptive-bubble separation, 22-30 to 22-36	fan drivers, 11-49
adsorption, <b>22</b> -32 to <b>22</b> -33	fans, 11-49
bubble fractionation, 22-35 to 22-36	finned-tube construction, 11-49
classification, 22-30 to 22-32	forced-draft, 11-48
column operation, 22-34	humidification chambers, 11-50
enriching, <b>22</b> -33	trim coolers, 11-50
	the second secon
foam-column theory, 22-33 to 22-34	tube-bundle, 11-48
foam considerations, <b>22</b> -34 to <b>22</b> -35	tubing, 11-48
limiting equations, 22-34	overhead condenser, 11-51
simple mode, 22-33	steam condenser, 11-51
stripping, 22-33	air filter:
advanced control system:	classification, 17-51
adaptive control, 8-20	high-efficiency particulate air (HEPA), 17-50 to
cascade control, 8-18 to 8-19	<b>17</b> -51
decoupling, 8-23 to 8-24	theory, 17-48 to 17-50
feedback, 8-17	types, <b>17</b> -50
feed forward, 8-16 to 8-18	air lift, <b>10</b> -35

air pollutants, effects of, 25-24 to 25-29	American Society for Testing and Materials
air-quality legislation and regulations, 25-5 to 25-9	(ASTM), 13-26, 13-86, 28-28
alanine, <b>2</b> -28	American Society of Mechanical Engineers
aldol acetaldol, 2-28	(ASME), 28-28
algae, 24-4	amino-anthraquinone, 2-28
algebra, 3-12 to 3-15	amino azobenzene, 2-28
binomial theorem, 3-13	amino benzoic acid, 2-28
factor theorem, 3-14	aminodiphenylamine, 2-29
fundamental theorem, 3-14	amino-G-acid, 2-29
permutations, 3-14	amino-J-acid, 2-29
probability, 3-14	amino monopotassium salt, 2-29
remainder theorem, 3-14	amino monosodium salt, 2-29
algebra, elementary, 3-12 to 3-15	aminonaphthol sulfonic, 2-29
binomial theorem, 3-13	aminophenol, 2-29
determinants, 3-15	aminotoluene sulfonic acid, 2-29
operations, 3-12 to 3-13	ammonia, 2-8, 2-53, 2-57, 2-85 to 2-88, 2-99,
permutations, combinations, and probability,	<b>2</b> -125, <b>2</b> -184, <b>2</b> -214 to <b>2</b> -216
3-14	ammonium acetate, 2-8
progressions, 3-13 to 3-14	ammonium auricyanide, 2-8
theory of equations, 3-14 to 3-15	ammonium bicarbonate, 2-8
algebraic inequalities:	ammonium bromide, 2-8, 2-57, 2-121, 2-201
arithmetic-geometric inequality, 3-9	ammonium carbonate, 2-8, 2-57
Carleman's inequality, 3-9	ammonium chloride, 2-8, 2-57, 2-99, 2-120, 2-201
Cauchy-Schwarz inequality, 3-9	ammonium chloroplatinate, 2-8
Hölder's inequality, 3-9	ammonium chloroplatinite, 2-8
Lagrange's inequality, 3-9	ammonium chlorostannate, 2-8
Minkowski's inequality, 3-9	
Alizarin, 2-28	ammonium chromate, 2-8
allyl alcohol, <b>2</b> -28, <b>2</b> -61	ammonium cyanide, 2-8, 2-57 ammonium dichromate, 2-8
allyl bromide, 2-28	
allyl chloride, 2-28, 2-61	ammonium hydrosulfide, <b>2-</b> 8, <b>2-</b> 57 ammonium hydroxide, <b>2-</b> 8
allyl thiocyanate, 2-28	
allyl thiourea, 2-28	ammonium ferrocyanide, 2-8
alum:	ammonium fluoride, 2-8
ammonium:	ammonium formate, 2-8
chrome, 2-8	ammonium molybdate, 2-8
iron, <b>2</b> -8	ammonium nitrate, 2-8
	ammonium nitrite, 2-8
potassium, 2-8	ammonium osmochloride, 2-8
potassium chrome, 2-8	ammonium oxalate, 2-8
sodium, 2-8	ammonium perchlorate, 2-8
aluminum acetate, 2-7	ammonium persulfate, 2-8
aluminum and alloys as construction material,	ammonium phosphate, 2-8 to 2-9
28-36	ammonium phosphomolybdate, 2-9
properties of, 28-43	ammonium silicofluoride, 2-9
aluminum bromide, 2-7	ammonium sulfamate, 2-9
aluminum carbide, 2-7	ammonium sulfate, 2-9
aluminum chloride, 2-7, 2-57, 2-121, 2-151, 2-161,	ammonium sulfide, 2-9
<b>2</b> -187, <b>2</b> -201	ammonium sulfite, 2-9
aluminum ethoxide, 2-28	ammonium tartrate, 2-9
aluminum fluoride, 2-7, 2-57, 2-161, 2-187, 2-201	ammonium thiocyanate, <b>2</b> -9
aluminum hydroxide, 2-7	ammonium vanadate, meta-, 2-9
aluminum nitrate, 2-7	amyl acetate, <b>2</b> -29, <b>2</b> -61
aluminum nitride, 2-7	amyl alcohol, <b>2</b> -29, <b>2-</b> 61
aluminum oxide, 2-7, 2-57, 2-151, 2-161, 2-187	amyl amine, <b>2</b> -29
aluminum phosphate, 2-7	amyl aniline, <b>2</b> -29
aluminum potassium silicate, 2-8	amyl benzoate, 2-29
aluminum potassium tartrate, 2-8	amyl bromide, 2-29
aluminum sodium fluoride, 2-8	amyl chloride, 2-29
aluminum sodium silicate, 2-8	amyl formate, 2-29
aluminum sulfate, 2-8	amyl i-butyrate, 2-29
American National Standards Institute (ANSI),	amyl i-cyanide, 2-29
<b>28</b> -28	amyl jodide 2-29

### I.6 INDEX

amyl isobutyl carbinol, 2-29	anthraquinone sulfonate, 2-30
amyl i-valerate, 2-29	anthranfin, 2-30
amyl mercaptan, 2-29	antimony, 2-9, 2-57, 2-151, 2-161, 2-187
amyl methyl propyl carbinol, 2-29	antimony chloride, tri-, 2-9, 2-57, 2-151, 2-161,
amyl n-butyrate, 2-29	2-187
amyl phenol, 2-29	antimony oxide, tri-, 2-9, 2-57, 2-151, 2-161, 2-187
amyl propionate, 2-29	antimony sulfide, penta-, 2-9
amyl salicylate, 2-29	antimony sulfide, tri-, 2-9
amylene, 2-30	antimony telluride, 2-9
analytic geometry, 3-16 to 3-20	antimonyl potassium tartrate, 2-9
plane analytic geometry, 3-16 to 3-18	antimonyl sulfate, 2-9
asymptotes, 3-16	antipyrene, 2-30
conic sections, 3-17	Antoine equation, 4-15
coordinates, 3-16	constants, 13-21
curves, 3-16 to 3-17	aperture, 19-18
line, <b>3</b> -16	apiole, <b>2</b> -30
parametric equations, 3-18	arabinose, 2-30
polar equations, 3-18	arachidic acid, 2-30
solid analytic geometry, 3-18 to 3-20	argon, 2-9, 2-20, 2-53, 2-57, 2-133 to 2-134, 2-140,
coordinate systems, 3-18 to 3-19	2-161, 2-217
lines and planes, 3-19	arithmetic-geometric, 3-9
space curves, 3-19	arithmetic progression, 3-9, 3-13, 3-32
surfaces, <b>3</b> -19 to <b>3</b> -20	arsanilic acid, 2-30
analyzers:	arsenic:
chemical-composition, 8-50 to 8-51	black, 2-9, 2-57, 2-151, 2-161, 2-187
chromatography, 8-51	crystalline, 2-9
infrared analyzers, 8-51	arsenic acid, 2-9
paramagnetism, 8-51	arsenic pentoxide, 2-9
sampling system, 8-52 to 8-53	arsenic sulfide, $di$ -, 2-9
ultraviolet and visible radiation, 8-51	arsenic sulfide, penta-, 2-9
anemometers:	arsenious chloride, 2-9
current meter, 10-10	arsenious hydride, 2-9
heated-thermocouple, <b>10</b> -10	arsenious oxide, 2-9
The same and the s	asbestos:
hot-film, <b>10</b> -10 hot-wire, <b>10</b> -10	A CONTRACTOR STATE OF THE STATE
The state of the s	flexible metal hose, 10-96
laser-Doppler, 10-11	pressure, 10-97
thermistor, 10-10	ASOG method, 4-26
turbine, <b>10</b> -10	asparagine, 2-30
vane, 10-10	asphalt as construction material, 28-49
anethole, 2-30	aspirin, 2-30
angle of kinematic friction, 21-28	ASME Code, <b>10</b> -144 to <b>10</b> -152
angle of repose, 21-27	atmospheric tanks, 10-138
anhydroformaldaniline, 2-30	definition of, 10-138
aniline, 2-30, 2-52, 2-61, 2-175, 2-184	elevated, <b>10</b> -138
aniline hydrochloride, <b>2</b> -30	open, 10-138
aniline nitrate, 2-30	posttensioned concrete, 10-138
aniline sulfate, 2-30	pressure, 10-138
anisalacetone, 2-30	atomizers, 27-34 to 27-35
anisic acid, 2-30	atropic acid, 2-30
anisic aldehyde, 2-30	auramine, 2-30
anisidine, 2-30	auric chloride, 2-9
anisole, 2-30	auric cyanide, 2-9
annual cash income, 9-5 to 9-6	aurine, coralline, 2-30
annual expense, 9-6	aurous chloride, 2-9
annual tax, 9-6	aurous cyanide, 2-9
annulus Reynolds number, 10-17	axial dispersion in adsorption, 16-20 to 16-21,
anthracene, 2-30	16-24, 16-34 to 16-37
anthranil, 2-30	coefficient, 16-17, 16-20 to 16-22
anthranilic acid, 2-30	azeotropes, 13-54 to 13-56
anthrapurpurin, 2-30	azeotropes, multicomponent, 13-10
anthraquinone, 2-30	azeotropic distillation, 13-68 to 13-75, 13-78. See
anthraquinone disulfonate, 2-30	also distillation

azoanisole, 2-30	bearings, types of (Cont.):
azobenzene, 2-30, 2-61, 2-175	cylindrical bore, 10-65
azoxybenzene, 2-30	lemon bore, 10-65
	offset halves, 10-65
	plain journal, 10-65
	pressure dam, 10-65
bacteria, 24-4	three-lobe, 10-65
baffles:	tilt-pad bearings, 10-65
cut, 11-42	beds:
impingement, 11-43	flooded fixed bed, 23-36
longitudinal, 11-43	fluidized, <b>23</b> -38, <b>23</b> -54
rod, 11-42	moving, <b>23</b> -38
" • DO VE	multiple fixed, 23-36
segmental, 11-42	single fixed, 23-36
spacer, 11-43	
spacing, 11-42	solid, 6-34, 6-38
ball-mill:	suspended catalyst, 23-54
liners, <b>20</b> -32	thin, <b>23</b> -38
oscillation, <b>20</b> -32	trickle, 23-53
planetary, <b>20</b> -39	Benedict-Webb-Rubin Equation of State, 4-21,
surge, <b>20</b> -32	13-17
barbituric acid, 2-30	benzal acetone, 2-30
barium, 2-57, 2-151, 2-161, 2-187	benzaldehyde, 2-30, 2-61
barium acetate, 2-9	benzamide, 2-30
barium bromide, 2-7 to 2-10	benzanilide, 2-30
barium carbonate, 2-10	benzene, 2-30, 2-51, 2-61, 2-175, 2-221
barium chlorate, 2-10	benzene sufinic acid, 2-30
barium chloride, 2-10	benzene sulfonic acid, 2-30
barium hydroxide, <b>2</b> -10	benzene sulfonic amide, <b>2</b> -30
barium nitrate, 2-10	benzene sulfonic chloride, 2-30
barium oxalate, <b>2</b> -10	benzidine, <b>2</b> -30
barium oxide, <b>2</b> -10	benzidine disulfonic acid, 2-30
barium peroxide, <b>2</b> -10	benzil, <b>2</b> -30, <b>2</b> -61
barium phosphate, 2-10	benzoic acid, 2-30, 2-52, 2-61, 2-175, 2-204
barium silicofluoride, 2-10	benzoic anhydride, 2-30, 2-61
barium sulfate, 2-10	benzoic nitrile, 2-30, 2-53, 2-61
barium sulfide, 2-10	benzoin, 2-31, 2-61
Barker's method, 4-27	benzophenone, 2-31, 2-61
barometer, mercury, 10-12	benzotrichloride, 2-31, 2-61
Basset force, 6-52	benzoylbenzoic acid, 2-31
batch:	benzoylchloride, 2-31, 2-61
centrifuges, 18-117	benzoylperoxide, 2-31
crystallation, 18-49	benzylacetate, 2-31, 2-61
distillation, 13-96 to 13-103. See also distillation	benzyl alcohol, 2-31, 2-61
filtration, 18-86 to 18-88	benzyl amine, <b>2</b> -31, <b>2</b> -62
heating and cooling of vessels, 11-18	benzyl aniline, 2-31
mixers, 18-25 to 18-29	benzyl benzoate, 2-31
operations, 11-18 to 11-20	benzyl butyrate, 2-31
percolators, 18-55	benzyl chloride, 2-31
processes:	benzyl ether, 2-31
cyclical batch, 8-38	benzyl formate, 2-31
flexible batch, 8-38	
	benzyl propionate, 2-31
multigrade, 8-38	berberonic acid, 2-31
semibatch, 8-38	beryllium, 2-10
trays and dryers, 12-42 to 12-44	Bessel's method, 3-37
weighing, 21-32	binary interaction parameters, 13-20
beach, 18-114	binary solution:
bearings:	behavior for liquid solutions, 4-12
thrust, 10-66	equation, 4-7
thrust-bearing power loss, 10-67	binomial probability distribution, 3-71
types of, <b>10</b> -65	Bernoulli process, 3-71
bed-expansion ratio, 11-28	binomial series, 3-32
circumferential grooved, 10-65	binomial theorem, 3-13

### I.8 INDEX

bin opening, <b>21</b> -29	bismuth nitrate, <b>2</b> -10
biochemical engineering, 24-3 to 24-22	bismuth oxide, 2-10
biological reactors, 24-7 to 24-15	bismuth oxychloride, 2-10
fermenters, 24-7 to 24-10	biuret, <b>2</b> -31
oxygen transfer to, 24-10 to 24-11	blending:
scale-up of, 24-11 to 24-13	of chemical reactions, 18-14
sparger systems in, 24-11	of high-viscosity systems, 18-13
cell cultures, 24-6 to 24-7, 24-14 to 24-15, 24-18	of solid dispersion, 18-16
to <b>24</b> -19	of solid-liquid, 18-15
primary growth, 24-6 to 24-7	of solid-liquid mass transfer, 18-16
secondary metabolic requirements, 24-7	of speed for just suspension, 18-15
enzyme engineering, 24-21 to 24-22	blinding, 18-76
immobilizing enzymes, 24-21 to 24-22	blowcase, 10-35
reaction kinetics, 24-21	blowdown drum, 26-31
reactors, 24-22	sizing and design, 26-35 to 26-36
process modeling, 24-16 to 24-21	blowers, 10-45 to 10-46
cell cultures, 24-18 to 24-19	backward-curved blade, 10-46
computer aids, 24-18	centrifugal, 10-45
continuous culture, 24-17	forward-curved blade, 10-46
controls, 24-20 to 24-21	boilers, 27-40 to 27-47
mathematical analysis, 24-17 to 24-18	boiling liquids, 5-22 to 5-23
mixed cultures, 24-19 to 24-20	coefficients, 5-22 to 5-23
recycle, <b>24</b> -19	expanding vapor explosions (BLEVEs), 26-59 to
product recovery, 24-15 to 24-16	<b>26</b> -60
rundown, definition of, 24-3	mechanisms, 5-22
sterilization, <b>24</b> -13 to <b>24</b> -14	Boltzmann-type T, 4-23
batch, <b>24</b> -14	bonding index, <b>20</b> -72
continuous, 24-14	bonnet, 11-40
by filtration, <b>24</b> -13	book value, 9-8
of media, <b>24</b> -13 to <b>24</b> -14	boric acid, 2-10
See also biological concepts	borneol, <b>2</b> -31
biological concepts, 24-4 to 24-6	bornyl acetate, 2-31
algae, 24-4	boron, 2-10
autotrophs and heterotrophs, definitions of, 24-4	• Park Park
bacteria, 24-4	boron carbide, 2-10
cells, 24-4	boron oxide, 2-10
fungi, <b>24</b> -4	boundary layer, 6-40 to 6-41
genetic engineering, 24-6	brass:
mutations, 24-6	as a construction material, 28-37
	properties of, 28-44
viruses, 24-4	brazing, 10-126
biochemical separation processes, 22-69 to 22-79	breakage:
final purification, 22-75 to 22-78	controlling, 20-70
chromatography, 22-75 to 22-78	fracture measurements, <b>20</b> -69
drying, 22-78	fracture properties, 20-68
lyophilization (freeze drying), <b>22-78</b>	mechanisms of, 20-69
general, 22-69 to 22-71	breakeven:
initial product harvest, 22-71 to 22-73	charts, 9-7
centrifugation, 22-71 to 22-72	production rate, 9-7
filtration, 22-72	breakthrough curves in adsorption, 16-30 to 16-38
initial purification, 22-73 to 22-75	in chromatography. See elution, curves
adsorption, 22-75	constant pattern, <b>16</b> -32 to <b>16</b> -36
extraction, 22-74 to 22-75	J function, <b>16</b> -36 to <b>16</b> -37
precipitation, 22-73 to 22-74	brick construction, 28-39, 28-43
biochemistry, 24-4 to 24-6	briquettes, 20-57
energy, <b>24-</b> 5	brittle fracture index (BFI), <b>20</b> -72
enzymes, 24-5, 24-21 to 24-22	bromic acid, 2-10
photosynthesis, 24-5 to 24-6	bromine, <b>2</b> -10, <b>2</b> -53
proteins, 24-4 to 24-5	bromine hydrate, 2-10
See also biological concepts	bromoaniline, 2-31
bismuth, 2-10, 2-57, 2-151, 2-162	bromobenzene, 2-31, 2-53, 2-62
bismuth carbonate, sub-, 2-10	bromocamphor, 2-31
bismuth chloride, 2-10, 2-57, 2-151	bromodiphenyl, 2-31, 2-62

cadmium sulfide, 2-11 bromoform, 2-31, 2-62 caffeic acid, 2-32 bromonaphthalene, 2-31 caffeine, 2-32 bromophenol, 2-31 calciners, indirect heat, 12-62 to 12-64 bromostyrene, 2-31 calcium, 2-11, 2-57, 2-100, 2-151, 2-162, 2-188 bromotoluene, 2-31, 2-62 calcium acetate, 2-11 bronzes as construction material, 28-37 calcium aluminate. 2-11 properties of, 28-44 calcium aluminum silicate, 2-11 Brownian motion, 6-57 calcium arsenate, 2-11 bubble point, 13-25 calcium bromide, 2-11 Buckingham pi method, 3-89 calcium carbonate, 2-11 bulk densities, 21-6 calcium chloride, 2-11 burners: calcium citrate, 2-11 gas, 27-37 to 27-39 oil. 27-35 to 27-36 calcium cyanamide, 2-11 calcium ferrocyanide, 2-11 butadiene, 2-31, 2-50, 2-62 calcium fluoride, 2-11 butadienyl acetylene, 2-31 butane, 2-31, 2-50, 2-62, 2-222 to 2-223 calcium formate, 2-11 calcium hydride, 2-11 butene, 2-50, 2-62 calcium hydroxide, 2-11 butyl acetate, 2-31, 2-52 calcium hypochlorite, 2-11 butyl alcohol, 2-31, 2-51, 2-62 calcium hypophosphate, 2-11 butyl amine, 2-31, 2-62 calcium lactate, 2-11 butyl aniline, 2-31 calcium magnesium silicate, 2-11 butyl arsonic acid, 2-31 calcium nitrate, 2-11 butyl benzoate, 2-31, 2-62 calcium nitride, 2-11 butyl bromide, 2-31, 2-62 calcium nitrite, 2-11 butyl butyrate, 2-31, 2-62 calcium oxalate, 2-11 butyl caproate, 2-31 calcium oxide, 2-11 butyl carbamate, 2-31 calcium peroxide, 2-11 butyl cellosolve, 2-31 calcium phosphate, 2-11 butyl chloride, 2-32, 2-62 calcium phosphide, 2-11 butyl dimethylbenzene, 2-32 calcium silicate, 2-11 butylene, 2-32 calcium sulfate, 2-11 to 2-12 butyl formate, 2-32, 2-63 calcium sulfhydrate, 2-12 butvl furoate, 2-32 butyl iodide, 2-32, 2-63 calcium sulfide, 2-12 butyl iso-thiocyanate, 2-32 calcium sulfite, 2-12 calcium tartrate, 2-12 butyl lactate, 2-32 butyl mercaptan, 2-32, 2-53 calcium thiocyanate, 2-12 butyl methacrylate, 2-32 calcium thiosulfate, 2-12 calcium tungstate, 2-12 butyl p-aminophenol, 2-31 butyl phenol, 2-32, 2-63 calculus, 3-23 to 3-30 differential calculus, 3-23 to 3-26 butyl propionate, 2-32 butyl stearate, 2-32 derivative, 3-23 to 3-25 indeterminant forms, 3-25 butyl valerate, 2-32 butyraldehyde, 2-32 partial derivative, 3-25 to 3-26 integral calculus, 3-27 to 3-30 butyric acid, 2-32, 2-52, 2-63 butyric amide, 2-32 definite, 3-29 to 3-30 indefinite, 3-27 to 3-29 butyric anhydride, 2-32 butyric anilide, 2-32 thermodynamics and multivariable calculus, 3-26 to 3-27 camphene, 2-32, 2-63, 2-175 camphor, 2-32 cadmium, 2-10, 2-57, 2-151, 2-162, 2-188 camphoric acid, 2-32 cadmium acetate, 2-10 cantharidine, 2-32 cadmium carbonate, 2-10 capacity: cadmium chloride, 2-10, 2-11, 2-57, 2-120, 2-151, terminology of, 10-22 2-188, 2-201 capillary state, 20-60 capillary theory, 12-33 cadmium cyanide, 2-11 capital cost, 9-7 cadmium hydroxide, 2-11 cadmium nitrate, 2-11 capping, 20-72 cadmium oxide, 2-11, 2-57, 2-151, 2-162, 2-188 capric acid, 2-32, 2-63, 2-175 caproic acid, 2-32, 2-63 cadmium sulfate, 2-11

### I.10 INDEX

caprylic acid, 2-32	catalysts (Cont.):
carbazole, 2-32, 2-63	single fixed beds, 23-36
carbitol, 2-32	types, <b>23</b> -28
carbon, 2-12, 2-57, 2-151, 2-162, 2-188	uniform deactivation, 23-31
as construction material, 28-49 to 28-50	cavitation, 6-44 to 6-45, 8-75 to 8-76, 10-23, 28-5
properties of, 28-61	cellosolve, 2-33
carbon dioxide, 2-12, 2-54, 2-63, 2-122, 2-125,	cellosolve acetate, 2-33
2-134, 2-141, 2-162, 2-188, 2-224 to 2-225	cells, <b>24</b> -4
absorption coefficients, 23-41	cellulose, 2-33
correlation of Kca, 23-41	cement and concrete as construction materials,
self-diffusion, 5-61, 5-64	28-43
as supercritical fluid in separations, 22-14 to	centrifugal force:
<b>22</b> -18	terminology of, 10-22
carbon disulfide, 2-12, 2-32, 2-54, 2-63	centrifugal pumps, 10-24 to 10-29
carbon monoxide, 2-12, 2-32, 2-54, 2-63, 2-122,	action of, 10-24
2-125, 2-141, 2-162, 2-188, 2-225 to 2-226	canned-motor, 10-29
as a pollutant, 27-28	casings, 10-24
carbon oxychloride, 2-12	characteristic curve of, 10-24
carbon oxysulfide, 2-12, 2-57	characteristics of, 10-24
carbon suboxide, 2-12, 2-32	close-coupled, 10-29
carbon tetrabromide, 2-32	double-suction single-stage, 10-28
carbon tetrachloride, 2-32	multistage, 10-29
carbon tetrafluoride, 2-32	diffuser-type, 10-29
carbon thionyl chloride, 2-12	dry-pit, <b>10</b> -29
carbonyl sulfide, 2-32	volute, <b>10</b> -29
carminic acid, 2-32	wet-pit, 10-29
carvacrylamine, 2-33	performance curve of, 10-26
carvone, 2-33	process pumps, 10-28
caryacrol, 2-32, 2-63	horizontal, 10-28
cash flow, 9-13 to 9-33	vertical, 10-28
curves of, 9-14 to 9-15	sealing in, 10-28
discounted, 9-13	mechanical seals, 10-28
casting:	packing, 10-28
circular, 10-24	shaft seals, 10-28
volute, 10-24	specific speeds of, <b>10</b> -25, <b>10</b> -27
cast iron, 28-29	sump, <b>10</b> -29
austenitic, 28-6	system curves of, 10-25
ductile, 28-29	vertical process, 10-29
gray, 28-6, 28-29	centrifugal separators:
high-silicon, 28-29	dust collection, 17-32
low-alloy, 28-6	centrifugation:
malleable, 28-29	biochemical separation, 22-71 to 22-72
nickel-alloy, 28-29	centrifuges, 18-106 to 18-125
properties, 28-38	cost of, 18-125
white, <b>28-29</b>	filtering, <b>18</b> -117 to <b>18</b> -123
catalysis:	base-bearing centrifuges, 18-117
homogeneous, 23-26, 23-32	batch-automatic basket centrifuges, 18-118
phase-transfer, 23-26	batch centrifuges, 18-117
by solid, <b>23</b> -26	continuous-filtering centrifuges, 18-119
catalysts:	link-suspended basket centrifuges, 18-117
activity, <b>23</b> -31	open-bottom basket centrifuges, 18-117
deactivation, 23-30	solid-bottom basket centrifuges, 18-117
diffusivity, 23-29	
effectiveness, 23-30	top-suspended centrifuges, 18-118 variable-speed basket centrifuges, 18-117
heterogenized, 23-26	principles of, 18-106 to 18-110
immobilized, 23-26	sedimenting, <b>18</b> -110
membrane reactors, 23-32	decanter centrifuges, 18-113
multiple fixed beds, 23-36	
poisoning, 23-32	disk centrifuges, 18-113
polymer bound, 23-26	knife-discharge centrifugal clarifiers, 18-112
pore, <b>23</b> -29 to <b>23</b> -31	laboratory test, 18-110
selection, <b>23</b> -26	multichamber centrifuges, 18-112
	screenbowl centrifuges, 18-115

centrifuges, sedimenting (Cont.): chromatography (Cont.): displacement development, 16-39, 16-44 to 16-47 transient centrifugation theory, 18-111 elution. See elution tubular-bowl centrifuges, 18-112 frontal analysis, 16-39 selection of, 18-123 Gaussian curves, 16-40 to 16-42 theory of centrifugal filtration, 18-121 ion-exchange, 16-44 centroid, 3-67 productivity, definition of, 16-47 ceric hydroxide, 2-12 resolution, 16-41 ceric hydroxynitrate, 2-12 retention factor, 16-40 ceric oxide, 2-12 reversed-phase, 16-44 ceric sulfate, 2-12 chromic acetate, 2-12 cerium, 2-12 chromic chloride, 2-12 cetyl acetate, 2-33 chromic fluoride, 2-12 cetyl alcohol, 2-33 chromic hydroxide, 2-12 channel, 11-40 chromic nitrate, 2-12 Chebyshev's method, 3-38 chromic oxide, 2-12 Chemical Exposure Index (CEI), 26-8, 26-11 chromic sulfate, 2-12 chemical potential: chromic sulfide, 2-13 pure ideal gases, 4-33 chromium, 2-12, 2-58, 2-162 chemical-reaction equilibrium constant, 4-32 chiller, definition of, 11-35 chromium trioxide, 2-13 chromous chloride, 2-13 chi-square distribution, 3-75 chloral, 2-33, 2-63 chromous hydroxide, 2-13 chloral hydrate, 2-33, 2-63, 2-175 chromous oxide, 2-13 chloranil, 2-33, 2-63 chromous sulfate, 2-13 chromous sulfide, 2-13 chloretone, 2-33 chloric acid, 2-12 chromyl chloride, 2-13 chrysene, 2-33 chlorine, 2-12, 2-53, 2-58, 2-122, 2-126, 2-162, chrysoidine, 2-33 2-229 to 2-230 chrysophanic acid, 2-33 chlonine hydrate, 2-12 cineole, eucalyptole, 2-33 chloroacetanilide, 2-33 cinnamic acid, 2-33, 2-64 chloroacetic acid, 2-33, 2-63, 2-175 cinnamic aldehyde, 2-33 chloroacetone, 2-33 cinnamyl alcohol, 2-33, 2-64 chloroacetophenone, 2-33 cinnamyl cinnamate, 2-33 chloroacetyl chloride, 2-33 citraconic acid, 2-33 chloroaniline, 2-33, 2-63 citral, 2-33, 2-64 chloroanthraquinone, 2-33 chlorobenzaldehyde, 2-33 citric acid, 2-33 chlorobenzene, 2-33, 2-53, 2-63 citronellal, 2-33 citronellol, 2-33, 2-64 chlorobenzoic acid. 2-33 chlorobuta-1,2-diene, 2-33 Clapeyron equation, 4-15 clarifiers: chlorobuta-1,3-diene, 2-33 chlorodimethylhydantoin, 2-33 cartridge, 18-102 chlorodiphenyl, 2-33, 2-64 micronic, 18-102 chloroform, 2-33, 2-64, 2-231 circular, 18-65 clarifier-thickener, 18-66 chlorohydroquinone, 2-33 design criteria, table, 18-72 chloronaphthalene, 2-33, 2-64 chloronitrobenzene, 2-33 industrial waste secondary, 18-66 rectangular, 18-65 chloronitrotoluene, 2-33 chlorophenol, 2-33, 2-64 selection of, 18-73 chlorophyll, 2-33 solids-contact, 18-66 tilted-plate, 18-66 chloropicrin, 2-33, 2-64 classification, wet, 19-23 to 19-30 chloroplatinic acid, 2-12 classifiers, 19-8, 19-24 to 19-30 chloropropane, 2-53 air, 20-39 chloropropionic acid, 2-33 chlorostannic acid, 2-12 bowl, 19-28 chlorosulfonic acid, 2-12, 2-58 bowl desilter, 19-28 chlorotoluene, 2-33, 2-64 cone, 19-24 countercurrent, 19-29 cholesterol, 2-33 —O siphon sizer, 19-29 choking, 6-22 to 6-23, 6-29 to 6-30 chromatography, 16-38 to 16-47 drag, 19-28 dry, 20-39 biochemical separation, 22-75 to 22-78 hydraulic, 19-29 chromatograms, 16-40

### I.12 INDEX

classifiers (Cont.):	external coils, 11-22
hydrocyclone, 19-24	fin-tube, 11-21
hydroseparator, 19-28	helical, 11-20
jet sizer, 19-29	panel, 11-21
nonmechanical, 19-24	pipe tank, 11-20
rake, <b>20</b> -40	plate, 11-21
rake and spiral, 19-28	Teflon immersion, 11-21
rotor blades of, 20-39	Colburn j factor, <b>5</b> -13 to <b>5</b> -14, <b>5</b> -16 to <b>5</b> -18
screw, <b>20</b> -40	in an annulus, 5-17 to 5-18
solid-bowl centrifuge, 19-28	combustion, 27-25
vari-mesh, <b>20</b> -39	excess air, <b>27</b> -25
wet, <b>20</b> -40	fluidized-bed, <b>27</b> -32
Clean Air Act of 1970, 25-5	gaseous fuels, 27-37 to 27-39
Clean Air Act of 1990, <b>25</b> -8	liquid fuels, 27-34 to 27-36
Clean Water Act of 1977, 25-10	solid fuels, <b>27</b> -29 to <b>27</b> -34
closure models, 6-46	theoretical oxygen, 27-25
cloth:	combustion chamber, 5-40 to 5-42
silk bolting, 19-22	bayonet-tube, 11-57
woven-wire, 19-22	in furnace, <b>5-4</b> 1
coal:	thermal performance, 5-41
coal-ash, <b>27</b> -5	common units, 1-4 to 1-12
coke, <b>27</b> -6 to <b>27</b> -7	compact heat exchangers, 11-52 to 11-58
composition, 27-5	atmospheric section, 11-57
classification, 27-4	brazed-plate-fin, 11-56
derived fuels, 27-11	cascade coolers, 11-57
derived gases, 27-14 to 27-15	ceramic, 11-58
gasification, 27-13 to 27-18	gasketed-plate, 11-52
heating value, 27-5	graphite, 11-57
liquefaction, 27-18	nonmetallic, 11-57
direct, 27-18 to 27-20	plate-and-frame, 11-52
economics, 27-24	plate-fin tubular, 11-56
indirect, 27-21 to 27-24	PVDF, 11-57
physical properties, 27-6	spiral-plate, 11-55
coalescence kernel, 20-86	spiral tube, 11-56
for granulation, table, <b>20</b> -87	Tetlon, 11-58
coating flows, 6-42	welded- and brazed-plate, 11-55
coatings, properties of:	compartment through circulation equipment,
in atmospheric service, 28-55	12-44 to 12-46
for concrete surfaces, 28-56	complex chemical-reaction equilibria, 4-33
in immersion service, 28-54	complex functions:
cobalt, 2-13	conformal mapping, 3-35
cobalt carbonyl, 2-13	exponential, 3-33
cobalt sulfide, di-, 2-13	harmonic, 3-34
cobaltic chloride, 2-13, 2-58	hyperbolic, 3-33
cobaltic hydroxide, 2-13 cobaltic oxide, 2-13	inverse hyperbolic, 3-34
cobaltic sulfate, 2-13	inverse trigonometric, 3-34
cobaltic sulfide, 2-13	logarithms, 3-33
cobalto-cobaltic oxide, 2-13	polynomials, 3-33
cobaltous acetate, 2-13	trigonometric, 3-33
cobaltous chloride, 2-13	complex variables, 3-33 to 3-35
cobaltous nitrate, 2-13	algebra, 3-33
cobaltous oxide, 2-13	complex functions (analytic), 3-34 to 3-35
cobaltous sulfate, 2-13	elementary complex functions, 3-33 to 3-34
cobaltous sulfide, 2-13	powers and roots, 3-33
coefficient:	special operations, 3-33
discharge, <b>6</b> -22	trigonometric representation, 3-33
orifice, <b>6-</b> 21	compressibilities, 2-140 to 2-150
thermal-expansion, 10-118	of powder, <b>20-71</b>
cogeneration, 27-51	compressibility factor, 4-8
coils:	partial compressibility factor, 4-18
bayonet heaters, 11-22	residual properties, 4-8
ony one chedicis, 11-42	formulations, 4-14

	1 (0 )
compression:	condenser (Cont.):
adiabatic, 10-37	jet, 11-117 multicomponent, 11-12 to 11-13
calculations, 10-37	overhead, 11-51
head, 10-37 equipment selection, 10-45	refrigeration, 11-83
of gases, 10-37 to 10-45	single component, 11-11 to 11-12
isothermal, <b>10</b> -37	surface, 11-116
polytropic, 10-37	thermal design of, 11-11 to 11-13
theory of, 10-37	horizontal in-shell condenser, 11-11
work, 10-38	horizontal in-tube condensers, 11-12
compressors:	mean temperature difference, 11-11
axial flow, 10-49	pressure drop, 11-11
aspect ratio, 10-49	vertical in-shell condensers, 11-12
individual blade stall, 10-49	vertical in-tube condensers, 11-12
pressure ratio, 10-49	condensing coefficient, 11-11
rotating stall, 10-49	conduction, 5-8 to 5-11
stall flutter, 10-49	conduction equation, three-dimensional, 5-8 to 5-9
casing material, 10-48	conductivity, thermal, 5-9
categories of, 10-47	Fourier's law, 5-8
centrifugal, 10-47	steady-state, 5-9 to 5-10 bodies in parallel, 5-10
pressure ratio, 10-47 configuration, 10-48	bodies in series, 5-9 to 5-10
selection of, 10-48	one-dimensional, 5-9
continuous-flow, 10-47	two-dimensional, 5-10
high-pressure compressors, 10-54	unsteady state, 5-10 to 5-11
metallic diaphragm, 10-55	one-dimensional, 5-10 to 5-11
nonlubricated cylinders, 10-53	phase change, 5-11
open inlet-valve unloaders, 10-53	two-dimensional, 5-11
piston-rod packing, 10-55	conductivity, thermal, 5-9
three-step control, 10-53	coniine, 2-33
valve losses, 10-52	consolidation:
impeller fabrication, 10-49	contact mechanics, 20-64
techniques, 10-49	controlling, 20-68
operating range:	deformability, <b>20</b> -64
choke, 10-48	granule, <b>20</b> -64
stonewall, 10-48	high-agitation intensity growth, 20-66
surge, <b>10</b> -47	low-agitation intensity growth, <b>20-</b> 65
positive displacement, 10-50	tensile strength, 20-64
reciprocating:	constant-composition systems, 4-5
clearance unloaders, 10-53	constants:
closed suction unloaders, 10-53	gas law, 1-18
control devices, 10-52	physical, 1-22
five-step control, 10-53	constrained derivatives, 3-66
rotary, <b>10</b> -50	continuity method (homotopy), 3-51
characteristic curve, <b>10-50</b>	continuous compound interest, 9-10 to 9-12 factors, 9-11
figures, 10-51	continuous stirred tank reactor, 23-17 to 23-19, 23-23
liquid-piston type, 10-51 screw-type, 10-50	continuous surfaces, 6-40 to 6-41
	continuous tunnels, 12-47 to 12-51
sliding-vane type, <b>10-</b> 51 straight-lobe type, <b>10-</b> 50	contraction strains, 10-103
selection of, 10-45	contribution charts, 9-7
speed of rotation of, 10-45	contribution efficiency, 9-37
computational fluid dynamics, 6-47 to 6-48	control:
computer process control, 8-4	feedback, 8-4, 8-17
condensation, 5-70 to 5-72	feed forward, 8-4, 8-16 to 8-18
coefficients, 5-20 to 5-22	multivariable control problems, 8-22
Dukler theory, <b>5</b> -20 to <b>5</b> -21	strategies for solution, 8-22 to 8-23
vapor shear control, 5-21	on/off, <b>8</b> -12
mechanisms, 5-20	proportional, 8-12
condenser:	proportional-plus-integral (PI), 8-12
barometric, 11-117	proportional-plus-integral-plus-derivative (PID),
definition of, 11-35	8-12

### I.14 INDEX

controller, 8-61 to 8-63	conversion factors, 1-4 to 1-14
distributed control systems, 8-61	common, 1-15 to 1-18
electronic controllers, 8-61	common to S.I., 1-4 to 1-12
fieldbus controller, 8-60, 8-62	examples of, 1-23
multiloop controllers, 8-61	metric, 1-13 to 1-14
pairing, 8-24	U.S. customary to S.I., 1-4 to 1-12
performance criteria, 8-13	water volume, 22-48
personal computer controllers, 8-62	conveyors:
pneumatic controller, 8-62 to 8-63	auxiliary equipment:
programmable logic controllers, 8-60, 8-61 to	brake, 21-5
8-62	cleaners, 21-5
reliability and application, 8-62	torque-limiting devices, 21-5
single-loop controls, 8-59 to 8-60, 8-62	belt conveyors:
tunning, 8-13 to 8-14	belt selection, 21-8
method, 8-15	belt width and speed, 21-9
control valves, 8-64 to 8-79	design, 21-8
ball valves, 8-65	idlers and return rolls, 21-9
booster relays, 8-71	
butterfly valves, 8-64 to 8-65	loading and discharge points, 21-10
	operating conditions, 21-9
contour-plug globe valves, 8-64	power, <b>21</b> -9
digital field communications, 8-72 to 8-73	pulleys, 21-8
fire, explosion protection, 8-72	tonnage requirement, 21-8
flow characteristics, 8-76 to 8-77	bucket elevators:
globe and angle valve, 8-64	continuous-bucket, 21-13
liquid pressure recovery, 8-74	horsepower, 21-14
manual, 8-67	skip hoists, 21-14
materials and pressure ratings, 8-73	spaced-bucket centrifugal-discharge, 21-10
plug valves, 8-65, 8-66	spaced-bucket positive-discharge, 21-10
positioners, 8-69 to 8-71	supercapacity continuous-bucket, 21-14
air spring rate, 8-71	V-bucket elevator-conveyors, 21-14
applications, 8-71	continuous-flow conveyors:
frequency response curves, 8-70	apron-conveyors, 21-18
pneumatic, 8-69	capacities, 21-19
stiffness, 8-69 to 8-71	closed-belt conveyor, 21-18
seals, bearings, packing system, 8-76	control of:
sizing, 8-73 to 8-74	process-control computers, 21-5
solenoid valves, 8-71	programmable controllers, 21-5
special application valves, 8-65 to 8-66	conveyor drives:
stem-position transmitters, 8-72	adjustable-speed drives, 21-5
trip valves, 8-72	fixed-speed drives, 21-5
valve application technology, 8-73	conveyor motors:
valve-control devices, 8-67 to 8-68	silicon-controlled rectifier, 21-5
vena contracta, 8-73	squirrel-cage motor, 21-5
convection, 5-12 to 5-19	feed selection, 21-4
forced, 5-14 to 5-19	flight-conveyors, 21-18
dimensional equations, 5-17	pneumatic conveyors, 21-19
laminar flow, <b>5</b> -15 to <b>5</b> -16	blow tank, 21-21
transition region, 5-16	capacity, 21-20
turbulent flow, <b>5</b> -16 to <b>5</b> -17	fluidizing gratema 91 00
heat transfer coefficient, 5-12 to 5-13	fluidizing systems, 21-20
energy equation, 5-12	optimum system, 21-20
film coefficients, 5-13	pressure system, 21-20
	pressure-vacuum systems, 21-20
individual coefficient, 5-12	vacuum systems, 21-20
overall coefficient, 5-12	screw conveyors:
liquid metals, 5-19	discharge arrangements, 21-7
natural, 5-13	feed arrangements, 21-7
dimensional equations, simplified, 5-13	gates, 21-8
enclosed spaces, 5-13	hanger bearings, 21-7
Nusselt equation, 5-13	hollow screws and pipes, 21-7
radiation, simultaneous loss, 5-13	jacketed casings, 21-7
nonnewtonian fluids, 5-19	power calculations, 21-7
convergent nozzles, 6-25	short-pitch screws, 21-7