

Index

a

absorption heat pump (AHP) 210
 activation energy 15, 16, 99
 active micromixers 65
 active mixers 63
 adductive crystallization 225
 adsorptive catalysts 199
 adsorptive distillation 237–238
 air gap membrane distillation 238
 ammonia oxidation 55
 Andrussow process 55
 Arrhenius equation 15
 azeotrope 211, 213, 235, 238

b

batch chromatographic reactor (BCR)
 216, 218, 220, 221
 bifunctional catalysts 199
 brute force techniques 18

c

carbon molecular sieves (CMS) 201,
 202
 carbonyl sulfide 202, 203
 catalyst-adsorbent distribution 200
 catalytic foam 30, 60, 61, 294
 catalytic partial oxidation
 of alkanes 291–293
 of cellulose 293–295
 catalytic reactors 27, 55, 61, 197, 290
 coupling and decoupling in 60
 Centrifugal Coriolis micromixer 65
 centrifugal micromixer 65
 chaotic advection micromixers 64

chemical looping combustion (CLC)
 268
 chemosensors 29, 33
 Chevron's Rheniforming process 199
 chloramphenicol 31, 32
 chromatographic reactors 216, 222
 coiled flow inverter (CFI) 206, 207
 compression-resorption heat pump
 (CRHP) 210
 contactor membrane reactors 214
 cyclic distillation 257, 271–276
 operation of 273
 cyclodextrin-assisted bromination 34
 cyclodextrin-confined compound 34
 cyclodextrins 17, 33, 34
 cyclohexane oxidation 55

d

degree of integration 197, 198
 degrees of freedom 60, 197, 198, 215,
 288, 305
 desorptive cooling 257, 286–288
 dielectrophoretic 64
 direct contact membrane distillation
 238
 discotic phases 38
 distributor membrane reactors 214
 double-walled batch reactor 313
 droplet micromixers 64
 drug purification 32

e

ecological assessment 303, 312–317
 electrokinetic 64
 electrowetting 64

EMITEC monolithic structures 57
 emulsion pertraction 246
 energy dissipation rates 67, 163, 164
 energy efficiency 110, 111, 141, 305,
 307, 311, 314, 317
 etherification of methanol 316
 exergy 311, 335
 exothermic reactions 39, 63, 70, 205,
 286, 287, 294
 extractive crystallization 225, 241–243
 extractive distillation 213, 235–238,
 316
 extractive metallurgy 231, 232
 extractor membrane reactors 214

f

feasible operation window 197, 198
 film diffusion 245
 flow focusing micromixers 64
 fluid catalytic cracking (FCC) 35, 166
 forced alignment methods 18
 fractal systems 71–73
 fuel gas combustion 263

g

gas–solid–solid trickle flow reactor
 215
 gauzes 55, 62, 291–293
 global warming potential (GWP)
 313–315
 green engineering 302, 303
 principles of 303, 305
 green process technology 302, 303

h

handling chemical reactions 234–235
 heat exchange (HEX)
 reactor 3, 208, 209, 334
 properties 39
 surface area 40
 heat integrated distillation column
 (HIDiC) 210
 heat/mass transfer 29
 heat pumping, in distillation systems
 209–211
 heat pumps 209

heat transfer coefficients 40, 47, 86, 88,
 91, 158
 high throughput screening (HTS)
 techniques 40
 homopolymerisation of styrene 315
 hydrodynamics modelling 29
 hydroformylation process 202
 hydroxyapatite (HAp) 261

i

in-line monolithic reactor 60
 integrated microstructured extraction
 system 54
 integrating hybrid separations
 techniques
 adsorptive distillation 237–238
 extractive crystallization 241–243
 extractive distillation 235–237
 membrane absorption/stripping
 242–245
 membrane chromatography
 (adsorptive membranes)
 245–246
 membrane crystallization 240–242
 membrane distillation (MD)
 238–241
 membrane extraction 246–247
 integrating reactions and separation
 211, 212
 membranes in chemical reactors
 213–219
 reactive absorption 226–227
 reactive adsorption 215–222
 reactive comminution 227–234
 reactive crystallization/precipitation
 223–225
 reactive distillation 211–215
 reactive extraction 222–224

l

Lorentz force 65

m

magneto-hydrodynamic 65
 mass efficiency 303, 305, 307
 mass/heat transfer 41
 mechanical alloying 231, 232

- mechanical vapor recompression (MVR) 210
 - membrane absorption/stripping 242–245
 - membrane chromatography (adsorptive membranes) 245–246
 - membrane crystallization 240–242, 311
 - membrane distillation (MD) 104, 238–241
 - membrane extraction 246–247
 - membranes-assisted distillation 238, 240
 - mesoscale baffle configurations 260
 - metal-organic frameworks (MOFs) 36, 37, 285
 - methanol-nitrogen mixture 52
 - methylamine synthesis 201
 - methylcarbamoyl chloride (MCC) 334, 335, 337
 - microchannel reactors
 - materials properties of 41
 - platelet 39
 - production-scale 42
 - scale-up versus numbering-up 42
 - microchemical processing systems 39
 - microfluidic distillation device 52
 - micromixers 63–66
 - microreactor engineering 313–316
 - microstructured reactors 39–45, 50, 321
 - microstructured separation systems 49–54
 - molecularly imprinted polymers (MIPs) 30, 31
 - protein crystals in 33
 - molecularly imprinted systems 17, 29, 33
 - synthesis and use of 31
 - monolithic catalyst 29, 30, 55, 56, 58, 60, 205
 - advantage of 58
 - single channel of 56
 - monolithic stirrer reactor (MSR) 22, 205
 - multifunctional adsorptive catalyst 200
 - multifunctional catalysts 199–202
 - multitubular fixed-bed reactor 27, 28
 - multitubular heat exchangers 72
 - multitubular reactor 27, 312, 321
- n**
- nanomaterials production 233
 - nitrophenol 34, 35
 - Nusselt number 40, 88
- o**
- one-pot reactions 199
 - open cross-flow structures (OCFS) 61, 62
 - oscillatory flow reactor (OFR) 257–262
- p**
- parallel lamination micromixers 64
 - passive micromixers 64
 - passive mixers 63
 - pervaporation 238, 240, 316
 - photocatalytic system 202
 - PI approaches
 - in randomness 27–29
 - structures targeting heat transfer 39–49
 - structures targeting mass transfer 49–63
 - structures targeting mixing and fluid flow 63–73
 - structures targeting molecular events 29–39
 - plate-and-shell heat exchangers 47
 - plate-fin heat exchangers (PFHEs) 47–49
 - plate heat exchangers (PHEs) 47, 208
 - pore diffusion 245
 - pre-exponential factor 15
 - pressure field 64
 - pressure swing adsorption (PSA) 284–286
 - printed circuits heat exchanger 46
 - process intensification
 - advantages of 303
 - approaches 8–11
 - case study of Bhopal 332–339

- process intensification (*contd.*)
 - classification of 308
 - definitions 5–8
 - design 331–332
 - disadvantages of 303–304
 - domains and scales 8–11
 - ecological assessment 312–317
 - equipment and methods 9
 - flexibility 307
 - in green technology 304
 - inherent safety 317–321
 - interdependency 308
 - interpretations 5–8
 - microreactor engineering 313–316
 - other intensified processes 316–317
 - principle 15–19
 - driving forces, resistances and interfaces 21, 22
 - experience molecules 19–21
 - synergies 21–23
 - principles 8–11
 - procedure for 332
 - quality 307
 - residence time 307
 - safety 307
 - simplicity 307
 - size of the installation 307
 - sustainability assessment 309, 310
 - sustainability assessment tools
 - applied to 303–312
 - sustainable processing 302–303
 - product selectivity 35, 36
 - pulse combustion (P-C) 275–284
- r**
 - reactant selectivity 35, 36
 - reaction and separation, structured
 - internals for 55–63
 - reaction rate 15, 18, 99, 135, 160, 199, 200, 211, 212
 - reactive absorption 226–227
 - reactive comminution 227–234
 - reactive crystallization/precipitation 223–225
 - reactive distillation 211, 215
 - reactive extraction 222, 224
 - residence time distribution (RTD) 67, 206, 235, 332
 - restricted transition state-type
 - selectivity 35, 36
 - reverse flow fixed bed reactor 268
 - reverse flow (RF)
 - operation 262, 264, 268, 269
 - reactors 262–269
 - Reynolds numbers 65, 66, 258
 - Rh-complex catalyst 202
 - rotating cylindrical annulus
 - chromatographic reactor (RCACR) 221
- s**
 - Sandwich Structures (SS) 61, 62
 - semi-rigid structures 38–39
 - separation factor 211, 212, 242
 - sequential lamination micromixers 64
 - shape-selective catalysts 17, 34–38
 - short contact time reactors 290–295
 - SiC foams 60
 - simulated moving bed chromatographic reactor ((SMBCR) 216, 218, 221
 - simulated moving bed membrane reactor 222
 - smectic phases 38
 - spatial structures
 - chemical processing, classes of 29
 - classification of 30
 - spiral heat exchangers 48, 49
 - Stark effect 18
 - static mixers 67–70, 142, 205, 206, 321
 - heat exchangers 205–207
 - reactors 205–207
 - stirred tank batch reactor 320
 - stirred tank reactors 20, 205, 235, 257
 - variable volume operation of 288–290
 - structured heat exchangers 46–49
 - structures targeting heat transfer
 - 39–49
 - microstructured reactors 39–45
 - structured heat exchangers 46–49
 - structures targeting mass transfer
 - 49–63

- microstructured separation systems 49–55
- reaction and separation, structured internals for 55–63
- structures targeting mixing and fluid flow 63–73
- fractal systems 71–73
- micromixers 63–66
- static mixers 67–70
- structures targeting molecular events 29–39
 - molecular imprints 29–33
 - molecular reactors 33–34
 - semi-rigid structures 38–39
 - shape-selective catalysts 34–38
- Sulzer Katapak-S structure 62
- sweep gas membrane distillation 238
- synergies molecular scale
 - multifunctional catalysts 199–202
 - use of alternative energy forms 202–204
- synergies processing units
 - heat exchanger (HEX) reactor 208–209
 - heat pumping in distillation systems 209–211
 - integrating catalysis and mixing 205
 - integrating reactions and separation 211–227
 - static mixer reactors and heat exchangers 205–207
- synergy 197–247

t

- tandem catalysis 199
- T-and Y-shaped micromixers 64

- Taylor flow 58, 59
- tert*-Amyl methyl ether (TAME) synthesis 316
- tert*-butylation reaction 37
- tetracycline hydrochloride 31, 32
- thermal flow reversal reactors (TFRR) 263, 265
- thermal vapor recompression (TVR) 210
- thermo-acoustic heat pump (TAHP) 210
- trickle bed reactors (TBR) 27, 28, 257, 270
 - periodic operation of 269–271
- true moving bed chromatographic reactor (TMBCR) 216, 218
- twisted nematics 38

v

- vacuum membrane distillation 104, 238
- valveless pulse combustor 278, 279, 281
- vapor compression (VC) 209
- volatile air methane (VAM) combustion 263
- volatile organic compounds (VOC) 102, 245
 - oxidation of 263

w

- waste generation 302, 303, 305

z

- zeolites 17, 30, 35, 37, 102, 285, 287

