

Index

- [bmim] [MeSO₄], 316, 339
- [bmim] [DCA], 319
- 1-cyclohexylethanol, 346
- 1-phenylethanol, 346
- acetophenone, 345–347, 349, 363
- Achromobacter xylosoxidans*, 325
- acoustic field, 297
- acoustic force, 297
- Adogen 464, 354
- agitator, 10, 42
- agrochemical industries, 341
- Aliquat 336, 342, 355–356
- alkane / aromatic separation, 317
- alkylations, 343, 351, 358
- aluminum fluorides, 314
- anionic surfactant, 289, 347, 356–357
- annular centrifugal contactor, 198
- antibiotics, 35, 37, 148, 168
- aprotic ionic liquids, 328
- asymmetric membranes, 130
- azeotrope, 315–316, 320
- azeotrope breakage, 315–316, 320
- Bacillus subtilis*, 326
- back-mixing, 6, 24, 26–27, 36, 43–44, 53, 144, 178, 189
- benzoin condensation, 359
- biocatalytic processes, 315
- biocompatibility, 324, 326, 333, 339
- bioprocessing, 147
- bioseparations, 46
- biphasic interface, 347
- boundary layer, 9, 88, 178
- breakup, 6, 9, 43, 59, 62, 64–65, 70, 72–73, 77–79, 115, 149, 167, 178, 211
- Brownian motion, 285
- butyl methyl imidazolium methyl sulfate, 316
- capillary number, 277
- cationic and anionic surfactant, 289
- cationic structures of ionic liquids, 313
- cell viability, 325, 333, 335
- cellulosic hollow fiber membranes, 148
- centrifugal contactors, 8
- centrifugal fields, 168, 186
- centrifugal forces, 3, 167, 169, 186, 202, 206–207
- centrifuge, 34–35, 46
- charge density, 214, 231–232, 234, 236, 238, 254, 259, 293
- charge transfer, 216
- chiral imidazolium ionic liquids, 327
- citric acid, 34, 147–148
- Clostridium butyricum*, 326
- cloud model, 248, 250, 262
- clouds of drops, 244, 247, 250
- coalescence, 2–3, 7, 9, 17–21, 25, 43–45, 47, 53, 59, 64–65, 70–72, 78–82, 103–104, 114–115, 127, 130–132, 134–135, 143, 145, 153, 166–167, 174, 182, 211, 244, 246, 254, 256, 269–274, 276–277, 279–287, 289–290, 292–294, 296–298, 302, 304, 306–307, 309–311
- coalescence time, 276, 278–279, 281, 289, 292–294, 298, 309
- coalescer, 18–19, 21–22, 272
- coalescing drops, 269, 271, 275–276
- coaxial rotating tubes, 203
- collision frequency, 44, 270, 282
- colloidal liquid aphron, 156
- column contactors, 6, 8, 23–24, 33, 47, 53, 63–65, 82, 114, 117, 121, 168, 225, 245
- commercial application, 155, 258, 263, 312, 319
- concentric cylinders, 196, 199
- conductivity, 223
- contaminants, 18, 54, 165
- convection, 9, 72, 90, 101, 103, 105, 107–108, 110, 112–113, 124, 126–129, 152, 195, 217, 254, 285
- copper ions, 154
- Coriolis forces, 186
- Couette flow, 196, 202–203, 208–209
- Coulomb's Law, 212
- coulombic charge, 215, 228, 245
- coupling reactions, 314, 358
- cyclopentene, 354

- Daphnia magna*, 324–325, 336
- decanter extractor, 35, 168
- deformation, 26, 47, 73–74, 80, 90, 92, 95, 97, 100–101, 124–125, 127–128, 226, 234, 258, 275, 281, 290, 303
- dielectric constant, 212, 222–223, 231, 236, 284, 289, 355
- dielectrophoresis, 219, 224
- Difasol, 320, 322–323
- Dimersol, 320–321, 323
- disk-type separator, 37
- disk speed, 174, 191
- dispersed phase hold-up, 43, 60
- dispersed phase mass transfer, 87, 91
- dispersion, 3, 6, 8–10, 13, 21, 24, 34, 42, 46–47, 50, 60, 62, 64, 69, 74, 78, 114, 133, 138, 145, 147, 149, 152, 156–157, 163, 176, 178, 180, 182–183, 200–201, 206, 209, 211, 215–216, 222, 225, 232, 244, 247–248, 250, 258, 262, 267, 269, 271–273, 284, 290, 294, 298, 303
- dispersion nozzle, 183
- distributed manufacturing, 1–2, 5
- DMSO, 326, 351
- double layer effects, 278, 285
- drop formation, 47, 49, 52, 64, 67, 78, 80, 82, 213, 222, 224, 227, 230, 232, 251, 256, 267
- drop shape, 54, 58, 88, 94, 100–101, 104, 108, 234, 280
- drop size, 2, 33, 36, 43, 46–47, 49, 53, 58–70, 72, 74–75, 77, 79–83, 114, 118, 132–134, 138, 149, 179, 182, 189, 200, 211, 216–217, 221, 224–226, 229–230, 232, 235, 241, 244–245, 247, 269, 271, 275, 277, 279, 281–283, 287, 290, 304, 310
- drop trajectory, 215, 242, 244
- drop volume, 48–50, 96, 98, 227–228, 230, 233
- drop–drop collision, 280
- droplet behavior, 43, 215
- droplet detachment, 49
- droplet distortion, 251
- droplet formation, 49, 82, 221, 232
- droplet phase, 9, 19, 25, 43, 74, 115, 138, 275, 285
- droplet reflection, 244
- droplet Reynolds number, 84
- ECP packed column, 26
- efficiency, 1–2, 5, 8, 11, 17, 24, 26–27, 36, 46, 53, 58, 64–65, 115, 117–118, 128, 146, 148–149, 152, 155, 187, 206–207, 211, 270, 281–283, 295, 300, 304, 307, 323
- electric field distribution, 234
- electrical double layers, 216
- electrical field, 130, 182, 185, 212–222, 224–230, 232, 234–235, 237–239, 241–242, 246, 249, 251, 254–256, 258–259, 262, 267–268, 284, 287
- electrical force, 216, 219, 228, 230–231, 239, 241, 258
- electrical gradient, 222
- electrical intensification, 265
- electrical potential, 213
- electrically induced phenomena, 211
- electroosmosis, 219
- electroosmotic flow, 219
- electrophoresis, 217–218, 224
- electrostatic dispersion, 245
- electrostatic enhancement, 211
- electrostatically induced instability, 245
- electrostatics, 211–212
- electroviscous forces, 292
- emulsified liquid–liquid systems, 135
- emulsion liquid membrane extraction, 153
- emulsion stability, 131–135, 138, 150, 166
- emulsions, 14, 17, 27, 43, 45, 79, 131–132, 134, 137–139, 143, 145, 149–150, 158, 162, 164–167, 302, 304, 310
- enantiomeric excess, 334
- enantioselective separations, 204
- energy saving, 2
- enhancement factor, 115, 118–119, 123
- environmental benefits, 1–2, 5
- environmental hazard, 270
- enzymatic hydrolysis, 220, 249, 263, 328
- enzymatically catalyzed interfacial hydrolysis, 220
- Eötvös number, 58, 119, 121
- equipment, 1–2, 5–6, 8, 11, 18, 20, 24, 26, 33, 37, 43–44, 47, 53, 58, 81–82, 95, 105, 114, 116–117, 121, 127, 132, 140, 142, 144, 167–168, 186, 198, 201, 205, 225, 244, 260, 263, 269, 271–272, 275, 322
- equipment size, 2, 20, 33, 142, 167, 186, 225, 263, 270, 322
- Escherichia coli*, 325, 327, 337–338
- etherifications, 343
- Eulerian approach, 246
- explosion hazard, 263
- external electrical fields, 211, 217
- extraction kinetics, 219
- extractive biotransformation, 332
- extractive fermentation, 332
- facilitated transport, 143, 154–155
- Fenton-type peroxidations, 328
- fibers, 145, 274, 307
- field strength, 218, 226, 228–230, 232, 234–235, 237–239, 246, 252, 259, 285, 287
- film drainage, 270, 278, 280–281, 283, 288, 291, 294, 302, 309
- film rupture, 276
- flow patterns, 41, 95, 113, 178, 209
- flow regimes, 176, 179, 189, 197, 203
- fluid mechanics, 1, 8, 174
- Gauss's law, 213
- Gaussian probability density function, 246, 250

- gravity settling, 17, 153, 271, 273
 green engineering, 4, 219
- halogenations, 314
 Hanson mixer settler column, 117
 Harkins correction factor, 48–50, 233
 heterogeneous catalysts, 176, 346
 hexadecyl tributyl phosphonium bromide, 341
 hexafluorophosphates, 315
 high gravity, 33, 44, 82, 167–168, 173, 182–183, 191, 201, 204, 206, 209
 high heat transfer rate, 172
 Hofmeister classification, 293
 hollow fiber, 140, 144–145, 148, 163, 165–166, 304–305
 hollow fibre bioreactor, 143
 hollow-fiber membranes, 140
 homogeneous catalysis, 320
 hybrid liquid membrane systems, 145–146
 hydraulic design, 44
 hydrocyclone, 167
 hydrodynamic disturbance, 1, 9, 26, 115, 244, 254
 hydrogel, 305–306
 hydrophilic surface, 303
 hydrophilicity, 136, 144, 305, 307
 hydrophobic ionic liquids, 314, 327
 hydrophobic tails, 347
- impeller, 9–10, 12–15, 17, 60–62, 72, 138, 179–180, 210
 impinging jet contactor, 174
 impinging jets, 173, 208
 inertial flow, 277–278
 initial rate, 255
 in situ extractive fermentation, 147
 intensification, 1–6, 8–11, 21, 24, 26, 33, 35, 42–43, 46, 58, 81–82, 95, 103, 113, 115, 130, 134, 142, 145–146, 153, 156–158, 165, 167, 169, 172–174, 176, 182, 185, 190–191, 196, 200, 204, 206, 208–209, 212, 215–219, 221–222, 245, 251–252, 256, 265, 270, 284, 287, 297, 312, 315, 343, 345, 356, 358–359, 363
 interelectrode distance, 228
 interfacial area, 1, 8–10, 43, 45, 47, 59–60, 79, 88, 90–91, 93, 95, 103–104, 132, 134, 137, 174, 176, 191, 200, 209, 211, 216, 221, 224–226, 234, 247, 251, 258, 269
 interfacial disruption, 216
 interfacial drainage, 275, 277–278, 281
 interfacial flows, 103, 107, 212, 219, 232, 254
 interfacial instabilities, 81, 87, 103, 128
 interfacial mass transfer, 12, 81, 95, 101, 103, 114
 interfacial polymerization, 132
 interfacial properties, 21
- interfacial tension, 10, 17–18, 33, 48–49, 59–62, 64–65, 68–69, 81–82, 94, 96, 102–105, 107–110, 112–113, 124, 134–135, 137–138, 140, 146, 187, 216, 227–228, 230–231, 233, 245–246, 254–255, 259, 274, 280–281, 290–291, 293, 304, 309
 interfacial turbulence, 103–107, 252, 255
 internal circulation, 1, 54, 56–57, 87, 95, 113, 125, 191, 221, 288
 internal recirculation, 94
 intramolecular forces, 245
 inventory cost, 155, 257
 ion exchange, 34, 154, 343
 ionic liquid membrane, 141
 ionic liquids, 3, 6, 41, 125, 140, 142, 257, 265–266, 312–320, 323–330, 333, 335–339, 355–356
 iron(II) catalyst, 348
- Karr column, 66–67, 77
 kinetics, 8, 24, 81–82, 106, 137, 155, 170, 174, 189–190, 192–193, 198, 217, 219–221, 224, 257, 262, 269, 272, 278, 283, 294, 332, 343, 347, 363
 Kolmogorov relationship, 138
 kosmotropes, 293
 Kühni columns, 66–67
- lactic acid, 144, 147–148, 325
Lactobacillus delbruekii, 325
 Lagrangian approach, 58, 95, 101, 125, 246, 249, 267
 liquid membrane systems, 131, 147, 150
 liquid–liquid contacting, 2, 7–8, 11, 18, 24, 26, 33, 35, 59, 95, 114, 117–118, 121, 140, 173, 176, 196, 270
 liquid–liquid emulsification, 131, 150
 liquid–liquid processes, 3, 5, 8, 14, 18, 47, 63, 81–82, 113, 134, 152, 211–212, 215, 219, 269–270, 312
- maintenance costs, 168
 Marangoni convection, 84, 112
 Marangoni disturbances, 103–104, 107, 110–112, 221
 Marangoni effects, 83, 113, 224, 254
 Marangoni flows, 113, 135
 Marangoni instabilities, 83, 101–103, 105, 111, 113, 128
 mass conservation, 193, 235
 mass transfer, 1, 5, 7–12, 14, 20, 24–26, 34, 36, 43–45, 47, 53, 58–59, 64–66, 69, 73, 77, 79, 81–84, 87–88, 90–93, 95, 99–102, 104–109, 111–115, 117–119, 121, 123–125, 127–129, 144, 146, 148, 155–156, 167, 170, 174, 176, 179, 182, 187, 189, 191–192, 198, 200–201, 205, 209–211, 215–216, 220–221, 224–226, 232, 234, 242, 245, 247, 249, 251–252, 254–256, 258–262, 265–266, 269–270, 332–333, 341, 343, 359

- mass transfer coefficients, 81, 83, 87–88, 90, 101, 103, 111–112, 115, 119, 121, 128, 170, 187, 221, 224
mathematical modeling, 9, 287
membrane separation, 130, 144, 151, 166
methyl imidazolium, 316
methyl trioctyl ammonium chloride, 341
microchannel, 46, 59
microemulsion, 131, 163
microextraction, 157
microporous membrane, 149
microwave energy, 356, 358
miniaturization, 9
mixer-settler, 8–9, 11, 18, 23, 33, 69, 119, 128
mixing, 3, 6, 9–10, 12–13, 18, 24, 26–27, 41, 43–44, 47, 58, 65, 81, 88, 101, 113, 115, 122, 131, 139, 170, 172–173, 175, 178–179, 182–183, 187, 189, 191, 195, 198, 201, 203, 209, 211, 221, 224, 226, 242, 247, 267, 272, 312, 318
molecular clusters, 198
multi-component flow, 189
N,N-dimethylformamide, 355
nanotubes, 306
Navier-Stokes, 54, 97, 107, 111–112, 189–190, 235, 258
neck velocity, 277
necking flow, 49–50, 52, 225, 227–228
new applications, 204
Newman formula, 261
nitration of xylene, 357–358
nitrations, 169, 343, 356
nitrocellulose membranes, 304
nonimpinging jet spinning disk, 174
nonlinear field, 230, 239
novel membrane materials, 305
nozzle geometry, 47, 228
nuclear industry, 5, 24
number density distribution, 261, 282
Ohnesorge number, 138
Oldshue–Rushton column, 117
oscillation, 53–54, 64, 70, 81, 83, 87–89, 91, 93, 101, 198, 221, 252, 277, 298
oscillatory flows, 63
oxidations, 354
packed columns, 24, 26, 68, 114
packed towers, 24
parallel plate impinging jet, 190, 198
particle cloud model, 246
partition coefficient, 95, 108, 113, 157, 335
p-chlorobenzyl chloride, 344
p-chlorobenzyl iodide, 345
p-chlorophenyl acetonitrile, 344, 363
pendant forming drop, 221
permittivity, 212–213, 218–219, 223, 231, 236, 241, 287, 289
pertraction, 131, 142–144
pharmaceutical, 5, 35, 37, 45, 130–132, 164, 187, 330, 341, 344, 346
phase inversion, 294, 310
phase separation, 3, 6, 8, 17–20, 33, 35, 37, 45, 59, 130, 132, 134, 140, 142–143, 174, 183, 186, 200–201, 211, 269–271, 284, 296, 302, 304, 307, 311, 344
phase separators, 18
phase-transfer catalysis, 176, 187, 217, 270, 315, 320, 341–344, 346, 349–351, 355–356, 358–359, 363–364
phenyl alkyl acetonitriles, 344
phosphonium cations, 313
photocatalytic degradation, 172, 208
photochemical reactions, 314
Pichia pastoris, 326, 337
Podbieliak, 33, 35, 168
Poisson differential equation, 236
Poisson's equation, 214
polymerization, 171–172, 198, 208, 343, 359
population balance, 70–72, 82, 282–283
power dissipation, 60, 64–65, 68, 200
predispersions, 184
product inhibition, 143, 147, 332–333
protic ionic liquids, 330
Pseudokirchneriella subcapitata, 324
Pseudomonas fluorescens, 326
pulsed fields, 252
pulsed perforated-plate extraction column, 119
pulsed plate columns, 65–66, 69, 114, 119, 256
quaternary ammonium compounds, 341
rate of coalescence, 291
Rayleigh limit, 216
reaction rates, 2–3, 81, 172, 345
reduction in plant size, 2
relaxation time, 223
renewable feedstocks, 330
residence times, 170
risk, 1, 27, 37, 145, 168, 265, 269
Robatel, 168
rotary contactor designs, 33
rotary contactors, 33, 35, 168
rotating contactors, 82, 168
rotating disk columns, 65
rotating tubular membrane, 206
rotational flow, 183
Rybaczynski Hadamard modification, 241, 272
safety, 1–2, 5–6, 35, 46, 168, 201, 265, 269, 315, 346
Sauter mean drop size, 139
scaleability, 176

- Schiebel column, 68
Schmidt number, 93, 118, 260
secondary dispersions, 21, 275
selectivity behavior, 3
separators, 38, 167, 185, 204, 210, 268
settling, 7, 12, 17–19, 24, 60, 132, 183, 186, 270, 272–273, 284, 310
shear rates, 167, 175, 179
Sherwood number, 84, 93, 121, 261
single drop mass transfer, 83, 90
sodium formate, 345–346, 348–349
solvating power, 312, 314
solvent properties, 3, 312
space charge, 217, 232, 235–237, 239, 246, 250
space charge distribution, 238–239
spinning disc contactors, 169
spinning disc reactor, 169, 179, 192, 208–210
spinning tube contactor, 196, 198
spray column, 24, 26, 78, 116, 121, 222, 252
stability criteria, 105
Staphylococcus aureus, 326
stirred tank, 11, 46, 63, 72, 74, 77–79, 152, 172, 322
stochastic transport, 248, 262
Stokes law, 77, 186
structured packings, 26
substrate inhibition, 332, 335, 346
sulfonations, 169, 343
supercritical fluid extractions, 34
supported liquid membranes, 131, 142–143, 145, 148, 166
surface activity, 106
surface charge, 146, 212–213, 217, 221, 223, 225, 230, 254, 270, 290
surfactant adsorption, 138
surfactant agents, 269
sustainable development, 4–5
Swarming droplet systems, 114
swarms of drops, 114, 245
Swirl number, 206–207
synergistic effects, 318
TBAB catalyst, 350
temperature field, 193
terminal velocity, 53–55, 58, 100
tetrabutyl ammonium bromide, 341
tetrabutyl ammonium tetrafluoroborate, 350
tetrafluoroborates, 315
three-phase system, 141
time-dependent deformation, 90, 100
toxicity, 3, 157, 315, 323–327, 330, 332–334, 336–339, 348
trajectories of multiple drops, 247
transfer hydrogenation, 341, 345–346, 348, 363–364
tungstic acid, 355–356
turbine mixers, 24
turbulent systems, 62
two-phase catalytic hydrogenation, 345
ultrasonic fields, 158, 296–298, 302
ultrasonics, 131, 158, 296, 298, 300, 302, 309–310
ultrasound, 158, 296, 298, 302, 356
unstable flow, 170
van der Waals forces, 278
velocity distribution, 43
velocity field, 98, 100, 115, 192, 194, 206, 238, 244
viscous forces, 74
vortex contactor, 183
waste minimization, 4
Weber number, 74
Westfalia, 33, 35
whole cell biocatalysis, 330
Wirz column, 67
zeta potential, 219, 285