Subject Index

A
Absorption, reactive
    process intensification, 2:881
Accident Ordinance (StörfallV), 2:975
Accident Release Information Program (ARIP), 2:978
Acrylene
    fuel, 2:728
Acute exposure threshold level, 2:937
Adiabatic reactor
    for nonhomogeneous, gas–liquid systems, 1:185
    for nonhomogeneous, solid–solid systems, 1:185, 187
    heat exchange in, 1:220
    homogeneous, isothermal, 1:182
    nonisothermal, 1:183
    temperature profile in, 1:220
Adipic acid
    synthesis, 2:805
Adsorption-distillation process
    process intensification, 2:891
Adsorption, reactive
    process intensification, 2:884
Agitator
    hollow blade radial flow, 1:633
Airlift loop reactor, 1:239
    downcomer, 1:241
Airlift reactor
    in biochemical engineering, 1:101
Algae
    definition, 1:483
Aluminum
    production in Hall–Héroult cells, 1:477
Ammonia
    two-stage converter, 1:323
Ammonius reactor, 1:646
AOD (Argon-Oxygen-Decarburization) converter, 1:454
Arc furnace, 466, 1:555
Archimedes number
    for fluidized beds, 1:385
Aris’ shape–generalized Thiele modulus, 1:80
Arresters
    for dusts, 2:1008
    flame, 2:1005
    for gases, 2:1002
Arrhenius number
    modified, 1:75
Aspergillus sojae
    solid-state fermentation of, 1:405
ATEX Directive, 2:1007
ATHEANA, 2:1034
Attrition
    in fluidized beds, 1:387
    of catalyst, 1:387
Autoignition temperature, 2:918
Axial dispersion
    in metallurgical processes, 1:155
    process
    laboratory studies, 1:163
    reactor
    mathematical treatment of, 1:26
    in flow models, 1:158

B
Baker equation, 2:1084
Baker–Striehow–Tang method, 2:1077
Basic process control system, 2:987
BASIL process, 2:820
Batch chromatographic reactor (BCR), 1:250
Batch cultivation, 1:109
Batch process
    laboratory studies, 1:163
Batch reactor
    mathematical treatment of, 1:26
    Bath smelting furnace, 1:451
Bayesian equation, 2:1084
Bayesian reliability data evaluation, 2:1027
Beek and Singer model, 1:207
Bent coiled tube reactor, 2:866
Benzene
    dream reaction, 2:808
    Bessemmer converter, 1:453
    Biochemical engineering, 1:83
    Biogas, 2:729
    Biomass
        fuel, 2:729
        in biochemical engineering, 1:144
    Biotechnology
        applications in fluidized-bed reactors, 1:404
    chemical reaction engineering in, 1:21
    Biot number, 1:41
    Blackman kinetics, 1:485
    Blast furnace
        equilibrium control, 1:160
    Bodenstein number, 1:204, 233
    Boiler, 2:738
    Boiling-liquid expanding-vapor explosion (BLEVE), 2:1072, 2:1079
    Bottom-Blown Oxygen Process (BOP), 1:454
    Boussinesq approximation, 1:209, 2:1051
    Box–Wilson method, 1:218
    Brode equation, 1:1084
    Bubble anomaly, 1:279
    Bubble behavior
        gas-evolving electrodes, 1:278
    Bubble-cap plate
        in fluidized-bed reactors, 1:379
    Bubble column
        gassing devices for, 1:144
        microalgal growth in, 1:489
    Bubble columns, 1:227
        backmixing, 1:233
        downcomer, 1:240
        types, 1:229
        Bubble coverage, 1:280
        Bubble curtain, 1:283
        Bubble detachment, 1:280
        Bubble distribution, 1:282
        Bubble flow
            in fluidized beds, 1:380
        Bubble geometry, 1:286
        Bubble growth
            in gas-evolving electrodes, 1:279
        Bubble-growth model, 1:381
        Bubble nucleation
            in gas-evolving electrodes, 1:279
        Bubble rise velocity, 1:232
        Bubble size
            bubble columns, 1:231
        Bubbling bed
            solid recycle system in, 1:386
        Bubbling fluidized bed, 1:393
        Buddy manager program, 2:1113
        Burke–Plummer equation, 1:210
        Burkhardt model, 2:1111
    Burner
        for combustors, 2:731
        Bursting disk, 2:996
    Butane
        fuel, 2:728
    Butanol
        fuel, 2:727
    Bypass
        in flow models, 1:158
Chemical reaction engineering, I:9
Chemineer CD6, I:633
Chemineer HE, 3, I:628
Chemostat, I:637
Chemshear CS2, I:636
Chemshear CS4, I:636
Chilton-Colburn analogy, I:74
Chromatographic reactor, I:249 analytical, I:271
anular, I:285
batch, I:263
macroscopic design, I:261
microscopic design, I:262
preparative, I:259
racemization processes, I:270
simulated moving bed, I:263
Chromatographic separation
process control, I:259
Circulating fluidized bed, I:382
Chromatography diagram in, I:385
Circulating fluidized-bed reactor, I:408
flow structure/flow structure of, I:409
Cleaning
plant and process safety, 2:963
Coal
fuel, 2:725
Coalescence
in stirred tanks, I:635
Coal
fuel, 2:726
Combustion
adiabatic flame temperature, 2:723
air/fuel ratio, 2:722
chemistry of gases, 2:722
chemistry of liquids, 2:723
chemistry of solids, 2:723
combustor types, 2:730
energy conversion, 2:730
flammability limit, 2:722
flashpoint, 2:723
heat transfer, 2:724
ignition, 2:722
laminar flame speed, 2:722
pollutant reduction, 2:724
process, 2:721
quenching, 2:724
safety aspects, 2:741
Computational fluid dynamics (CFD), I:409
airlift loop reactor, I:244
bubble columns, I:236
in microreactor simulation, I:575
stirred tanks, I:639
Configurational-bias Monte Carlo method, 2:814
Continuous cultivation, I:111
Continuous, ideally mixed, stirred-tank reactor
concentration ratio of different reaction order, I:191
kinetics, I:193
mathematical treatment of, I:27
Continuous, ideally mixed, stirred-tank reactor, I:190
Continuous rotating annular chromatograph (CRAC), I:250
Continuous stirred tank reactor (CSTR)
bypass, I:158
cascade of, I:197
isothermal heterogeneous system, I:194
kinetics, I:192
nonisothermal, mathematical treatment of, I:194
residence-time distribution, I:192
schematic, I:155
Control of Industrial Major Accident Hazards (CIMAH) Regulation, 2:977
Control of Major Accident Hazards (COMAH) Regulation, 2:977
Converter, I:452
COP micro evaporator, I:550
Copper smelter, I:464
Cracking, thermal
of naphtha, I:400
Crucible furnace, I:456
Crucible induction furnace, I:470
compact vacuum, I:470
line-frequency, I:471
medium-frequency, I:472
vacuum chamber, I:471
Crude oil

fuel, 2;727
Crystallization-chromatography process
process intensification, 2;891
Crystallization-distillation process
process intensification, 2;890
Crystallization, reactive
process intensification, 2;882
Crystallizer
mixed suspension, mixed product removal, 1;637
Current density
in gas-evolving electrodes, 1;287
Cyclohexanol
synthesis, 2;803
Cyclohexene hydration process, 2;805
Cyclone
in fluidized-bed technology, 1;395
Cyclone mixer, 1;524

D
Danköhler number, 1;30
process intensification, 2;851
Danckwerts penetration model, 1;34
see also Penetration theory
Darcy–Oberbeck–Boussinesq model, 1;209
Darcy’s law, 1;209
modified, 1;209–210
Davidson model
for fluidized beds, 1;380
Dead-end polymerization, 1;117
Dead-end reactor, 1;637
Dead volume
in flow models, 1;158
Dean number
for microreactors, 1;578, 584
Dean vortex, 1;488
Degasification-to-denotation transition, 2;928
Degree of reactor utilization, 1;60–61
Degussa BMA reactor, 1;233
DEMS reactor, 2;854
Density functional theory
process intensification, 2;811
Derived minimal effect level, 2;938
DESIGNER
for design of reactive distillation processes, 1;614
Dextran
production in a chromatographic reactor, 1;269
1,3-Dialkylimidazolium chloroaluminate, 2;819
Dialysis cultivation, 1;115
Diatom pump
in biochemical engineering, 1;149
Diels–Alder reaction
of butadiene, 1;667
Diesel fuel, 2;726
Difasol process, 2;819
Differential thermal analysis (DTA)
plant and process safety, 2;943
Dimensionless distribution coefficient, 1;36
Dimensionless group, 1;278
Dimensionless penetration coefficient, 1;34
Dimersol X process, 1;239
Distillation catalyst, 1;610
Distillation column
energy efficiency, 2;698
Distillation, reactive
applications of, 2;879
process intensification, 2;877
Double-skeleton electrode, 1;291
Down cell, 1;478
Drift flux model
airlift loop reactor, 1;241
Dust explosion, 2;923, 1081
Dusty-gas model, 1;53

E
Effective diffusion coefficient, 1;46
Effectiveness factor, 1;47
electro-arc furnace, 1;455, 467
Electrochemical cell
design, 1;298
Electrochemical reactors, 1;277
design, 1;296
Electrodes
bulk, 1;295
horizontal, 1;283
three-dimensional, 1;283
three-dimensional, bed-current density, 1;294
three-dimensional, geometric arrangement, 1;292
three-dimensional, kinetics, 1;293
three-dimensional, vertical, 1;283
Electrodes, horizontal
in electrochemical reactors, 1;289
Electrodes, microporous
in electrochemical reactors, 1;290
Electrode surface
bubble behavior, 1;278
Electrodes, vertical
in electrochemical reactors, 1;288
Electromagnetic casting (EMC), 1;469
Electron-beam furnace, 476, 1;456
Electron-beam melting (EBM), 1;455
Electropolishing
in biochemical engineering, 1;124
Electroslag refining process (ESR), 1;464
Electrothermal furnace, 1;455
production of metals from raw materials
by reduction, 1;456
recovery of metals in, 1;457
reforming of specific metals, 1;456
smelting and melting in, 1;458
Electrothermaldender, 1;454
Eley–Rideal mechanism, 1;19
Emergency Planning and Community Right-to-Know Act (EPCRA), 2;978
Endothermic reaction, 1;13
Endothermic reaction
in metallurgical furnaces, 1;448
Energy
storage, 2;739
Energy management, 2;685
Enhancement factor, modified, 1;69
Environmental Emergency Plan, 2;980
Enzyme membrane reactor, 1;430
Eötvös number, 1;239, 655
Ergun equation, 1;655
Ethanol
fuel, 2;727
ETHERMAX process, 1;619
Ethylene
preparation in a chromatographic reactor, 1;266
Euler–Euler formulation, 1;606
Euler–Euler model
see Two-fluid model
Euler–Lagrange model,
see Discrete bubble model
European emission trading system, 2;688
Event tree analysis, 2;1017
Exergy analysis
in plant design, 2;691
Exothermic reaction, 1;13
runaway potential, 2;939
safety evaluation, 2;941
Explosion, 2;1075
cases of, 2;1075
classification into groups, 2;1007
condensed substances, 2;926
definition, 2;926
gas, 2;742
mechanism, 2;927
models, 2;1075
Explosion groups, 2;919
Explosion limit, 2;907
determination, 2;909
temperature and pressure, 2;911
Explosion protection, 2;1002
Explosive substances
in stirred tanks, I:633
Flow
flow distribution in microreactors, I:575
laminar, I:626
in packed-bed reactors, I:209
in thin-film reactors, I:643
turbulent, I:626
Flow number for stirred tanks, I:627
Flow regime
heterogeneous or churn-turbulent, I:230
homogeneous, I:230
slug flow, I:230
Flow separation, I:553
Fluid dynamics
bubble columns, I:235
Fluidized bed circulating mass flow rate of solids in, I:384
horizontal gas mixing in, I:393
large-diameter, I:391
plant-scale, I:391
pressure gradient in, I:384
residence time of solids in, I:392
solids concentration in, I:384
Fluidized-bed combustor, I:273
Fluidized-bed drying, I:392
Fluidized-bed electrode, I:295
Fluidized-bed fermenter, I:405
Fluidized-bed furnace high-pressure combustion in, I:400
incineration of sewage sludge in, I:402
Fluidized-bed reactor, I:371
bed forms for, I:373
in biochemical engineering, I:114
biogas production in, I:404
biotechnology applications in, I:404
bubbling, I:407
catalytic reaction in, I:389
eutrination in, I:382
estimation of transport disengaging height, I:382
fluid-mechanical principles, I:374
gas distribution in, I:380
gas mixing in, I:392
gas–solid reaction systems, I:375
Geldart diagram for, I:376
heterogeneous catalytic gas-phase reaction in, I:396
mathematical modeling, I:406–407
multiscale CFD modeling of, I:410
noncatalytic gas–solid reaction in, I:389
polymerization of olefins in, I:399
pressure profile in, I:382
Scale-up, I:411
synthesis of acrylonitrile in, I:397
two-phase model, I:408
Wirth state diagram for, I:380
Fluidized-bed reactor, I:378
Fluidized-bed systems, I:410
Forced-flow membrane reactor, I:431
Forchheimer model, I:209
Frank–Kamenetzki approximation, I:79
temperature profile, I:2939
Frequency distribution, I:223
Froude number, I:235
for fluidized beds, I:383
for gas-evolving electrodes, I:285
low fuel vapor, I:2063
for stirred tanks, I:626
Fuel
characterization, I:725
Furnace, I:731
Fused-salt electrolysis cell, I:477
sodium recovery in, I:478
G
Galileo number, I:243
modified, I:655
for trickle-bed reactors, I:655
Gas
chemically unstable, I:917
combustion systems, I:735
flammability, I:914
oxidizing potential, I:915
Gas chromatographic reactor, I:266
Gas distribution
bubble columns, I:229
Gas distributor
for fluidized beds, I:379
horizontal gas jets, I:380
vertical gas jets, I:380
Gas engine, 2:735
Gas evolution efficiency, I:282
Gas-evolving electrodes, I:277
backflow, I:284
charge-transfer overpotential, I:287
diffusion overpotential, I:287
mass transfer, I:285
Gas-heated reformer, I:333
Gas-lift systems
in electrochemical reactors, I:291
Gas-liquid systems
in stirred tanks, I:632
Gas-solid Fluidized-bed reactor
mathematical modeling, I:407
Gas-sparged reactor, I:633
Gasification, 2:733
Gas–liquid hydrodynamic models, I:236
Gasoline, 2:726
GASP, 2:1043
Gas sparger, dynamic, I:229
ejector jet nozzle, I:229
momentum-transfer tube, I:229
two-phase jet nozzle alone, I:229
Venturi tube, I:229
Gas sparger, static, I:229
dip tube, I:229
perforated plates and ring, I:229
porous plates, I:229
Gas tungsten arc welding (GTAW)
in biotechnology, I:117
Gas turbine, 2:735
Glass
in biochemical engineering, I:125
Globally harmonized system (GHS), 2:972
for the classification and labelling of
chemicals, 2:906
Glucose
isomerization of, in a chromatographic reactor, I:268
Graphite furnace, I:685
Greenhouse gas emission
energy management, 2:688
H
Haldor Topsoe HTCR reformer, I:333
Hardware fault tolerance, 2:989
Hashimoto chromatographic reactor, I:254
Hatta number, I:652–64
modified, I:659
Hazard
characteristics of exothermic processes, 2:942
Hazard and operability study (HAZOP)
guide words, 2:1018
plant and process safety, 2:1015
Hazard assessment, 2:958
Hazard classes, 2:907
Hazardous materials
handling, 2:961
Hazardous substances
carcinogenic properties, 2:934
classification, 2:929
exposure control, 2:935
plant and process safety, 2:906
regulations, 2:930
short-term exposure limits, 2:937
toxic effect, 2:931
Health and Safety at Work (HASAW) Act, 2:977
Heat and power (CHP) plant, 2:686
Heat exchanger
counterflow, I:540
cross-flow, I:539
electrically powdered, I:542
energy efficiency, 2:598
heat pipe, I:544
induction heating, I:542
microwave, I:542
optimum heat recovery, pinch technology, 2:712
pinch technology, 2:713
process intensification, 2:849
without heat recovery, pinch technology, 2:711
Heat exchanger network (HEN), 2:710
Heat-exchanger reactor, I:604
countercurrent, I:604
2D finite-volume simulation, I:605
3D finite-volume simulations, I:605
Heat-integrated distillation column (HIDIC), 2:695
Heat-transfer coefficient, I:74
Heating
types of, in metallurgical furnaces, I:456
with laser, I:456
Heat transfer
airlift loop reactor, I:244
bubble columns, I:235
in gas-evolving electrodes, I:287
in microrreaktors, I:581
process-to-process, 2:708
with reaction in series, I:74
with simultaneous reaction, I:79
in thin-film reactors, I:643
in trickle-bed reactors, I:658
Hess's law
for simultaneous reactions, I:54
High-temperature Winkler (HTW) process, I:403
Hinterland ratio, I:60
Holdup gas
airlift loop reactor, I:252
bubble columns, I:233
Holdup, liquid
dynamic, I:555
external, I:555
internal, I:555
residual, I:555
Honeycombs, 2:587
Human error
plant and process safety, 2:1030
Hybrid membrane process, 2:891
Hydroformylation
catalysts for, 2:809
Hydrogen
fuel, 2:728
release from gas-evolving electrodes, I:281
Hydrogen peroxide propylene oxide (HPPO) process, 2:802
Hydrophilic polyalkene oxide (PAO), 2:827
Hyflon membrane, I:436
I
Impeller
for stirred tanks, I:627
marine-type, I:191
Incident Ordinance (StörfallV)
plant and process safety, 2:1144
Induction furnace, 409, I:456
channel induction, I:469
crucible induction, I:469
special, I:474
Inoculation, I:109
Interelectrode gap
flow in, I:283
Ohmic resistance of, I:282
Interfacial area, specific
bubble columns, I:234
Internal combustion engine, 2:734
Ionic liquids
process intensification, 2:818
Iron blast furnace, I:450
Isasmelt process, I:452
J
Jet fire, 2:1072
Joule effect
in furnaces, I:468
Joule–Thomson microcooler, I:541
Joule's law
application of, in electrothermal furnaces, I:458
KATAMAX – Metallurgical processes

Lagragian particle tracking, I:592–593
Laminar flow
in metallurgical processing, I:155
in stirred tanks, I:626
in straight microchannels, I:575
Langmuir kinetics, I:550
Arrhenius curve for, I:18
Langmuir–Hinshelwood theory, I:19
in bimolecular reactions, I:51
oxidation rate of NO, I:217
Large Eddy Simulation (LES), I:639, 2:1047
Laser heating, I:456
Layer of protection analysis (LOPA), 2:1036
Lenz’s law
for furnaces, I:470
Lewis number, I:74
Life-cycle analysis
micro process technology, I:497
Lightnin’ A 315, I:628
Lightnin’ KT-3, I:632
Limiting oxygen concentration, 2:925
Linde’s isothermal reactor, I:326
Linz-Donawitz Arbed Centre process (LDAC), I:454
Linz-Donawitz process (LD), I:454
Liquefied petroleum gas
fuel, 2:728
Liquid chromatographic reactor, I:268
Liquid fuel
characterization, 2:725
combustion systems, 2:734
types, 2:726
Liquid–liquid biphasic catalysis, 2:820
Liquid–liquid systems
in stirred tanks, I:634
Liquids
combustibility, 2:921
Liquid-solid fluidized-bed reactor
mathematical modeling, I:406
Ljungström heat-exchanger, I:351
Lockhart–Martinelli parameter, I:656
Log-normal distribution, I:1028
Loss control concept, I:1104
Lower explosion limit, 2:925
Lower flammability concentration, 2:1055
Lower flammability distance, 2:1053
Lubricants
in biochemical engineering, I:125
Lummus SRT furnaces, I:669
Lurgi fixed-bed gasifier, I:398
Lurgi Sand-cracker, I:400
M
Macroconvection
in gas-evolving electrodes, I:278
Macrofluid, I:22
Macrokinetics, I:21
heat transfer, I:74
mass transfer without reaction, I:32
mass transfer with reaction, I:36
Macromixing, I:22, 630
residence-time distribution in, I:22
Magnetizing roasting, I:443

Major accident hazards, 2:972
Major accident prevention policy (MAPP), 2:971
Major Industrial Accidents Council of Canada (MIACC), 2:979
Maleic anhydride
from benzene and butane, 2:798
Management
busienss continuity, 2:1124
of change process, 2:1126
of crisis, 2:1124
emergency response, 2:1124
work procedure, 2:1127
Management system
audits and reviews, 2:1129
contractors process, 2:1119
design and principle, 2:1116
holistic, 2:1135
integrated, 2:1131
process safety process, 2:1120
success factors, 2:1132
training process, 2:1118
Marangoni effect
in gas-evolving electrodes, I:279
Mass-expansion coefficient, I:210
Mass transfer
airlift loop reactor, I:242
bubble columns, I:234
effectiveness factor, I:72
efficiency enhancement factor, 72, I:70, I:72
gas side, in trickle-bed reactors, I:657
in a nonporous particle, I:37
in a porous particle, I:46
in gas-evolving electrodes, I:285
in microreactors, I:589
in thin-film reactors, I:644
liquid side, in trickle-bed reactors, I:657
macrokinetics in, I:32
microconvective, I:286
two-phase convective, I:286
with reaction in series, I:56
with simultaneous reaction, I:45
Mass-transfer coefficient, 74, I:35
of film theory, I:56
of Higbie penetration model, I:54
of surface renewal model, I:55
Maximum experimental safe gap, 2:918, 1007
Maximum explosion pressure
gas, 2:920
powder, 2:925
Maximum oxidizing gas concentration, 2:914
Maximum permissible flammable gas concentration, 2:914
Maximum rate of pressure rise, 2:920
Maximum temperature of synthesis reaction, 2:950
Maximum temperature of technical reason, 2:950
Mazzoni multitupe reactor, I:648
Membrane bioreactor
integrated or submerged, I:433
recirculated or external, I:433
Membrane contactor, I:422
Membrane distributor, I:422
Membrane extractor, I:421
Membrane filter
in biochemical engineering, I:147
Membrane preparation, I:435
Membrane reactor, I:419
catalytically active membranes, I:434
catalytically inert or passive membrane, I:434
classification, I:419
inorganic membranes, I:423
membrane-assisted catalysis, I:434
organic membranes, I:426
process intensification, 2:887
Membranes
catalytic, I:429
catalytically active, I:434
catalytically inert or passive, I:434
photoreactor, I:428
Mesomixing, I:631
Metallurgical furnace, I:439
Metallurgical processes
equilibria control, I:160
kinetic process, I:160
modeling, I:164

INDEX
rate equations via artificial intelligence, 1:166
real, 1:159
residence time distribution, 1:159
Metallurgical processing – Newton number (power number), 1:153
Methane combustion, 2:722
dream reaction, 2:807
Methanol
fuel, 2:727
i-Methionine
production in chromatographic reactor, 1:270
MFI (silicalite) membrane, 1:424
Michaelis–Menten kinetics, 1:20
Microalgae
aerated, 1:487
carbon dioxide supply, 1:487
light attenuation, 1:485
light fluctuation, 1:486
light saturation and dilution, 1:484
Microalgae reactor, 1:483
computational fluid dynamics, 1:487
surface-to-volume ratio, 1:485
types, 1:488
Microcalorimetry
plant and process safety, 2:946
Microchannel
converging–diverging, flow in, 1:577
curved, flow in, 1:576
curved, heat transfer in, 1:582
straight, flow in, 1:575
straight, heat transfer in, 1:582
Micro chromatography, 1:558
Microcombustion, 2:744
Microconvective
in gas-evolving electrodes, 1:278
Micro distillator, 1:556
Microemulsion
process intensification, 2:829
Microevaporators, 1:550
Micro extractor, 1:554
Microfluid, 1:22
Micro heat exchanger, 1:537, 587
classification, 1:539
foiling, 1:548
heat exchange fundamentals, 1:537
heat transfer in microchannels, 1:545
scale-out, 1:548
Microkinetics, 1:11
Micro membrane reactor, 1:559
Micronixer, 1:590
chaotic, 1:592
cross-channel, 1:594
multilamination, 1:594–595
process intensification, 2:847
Micronixers
bended, 1:527
chaotic advection, 1:526
classification, 1:518
design development, 1:528
diffusion-based, 1:521
hydrodynamics, 1:531
laminar flow, 1:522
microfabrication, 1:528
mixing characterization by PIV, 1:530
mixing principles, 1:518
modeling, 1:528
multilamination mixing, 1:522
split and recombine, 1:524
T-type, 1:521
turbulent, 1:527
Y-type, 1:521
Micromixing, 1:590, 630
in a stirred vessel, 1:28
Microorganism
growth and bioreaction, 1:87
growth rates and Michaelis–Menten constant, 1:88
suitable equipment for specific processes and products of, 1:118, 120, 122
Micro process technology, introduction
concepts, 1:496
constraints, 1:495
green chemistry, 1:498
Microreactors
3D solution to flow distribution problems, 1:579
micro process technology, 1:500
multichannel flow domains, 1:578
multichannel, heat transfer, 1:584
process intensification, 2:850
reduced-order flow model, 1:579
Microreactors, modeling and simulation
CFD simulations, 1:579
chemical kinetics, 1:600
flow distribution, 1:575
heat transfer, 1:581
mass transfer, 1:589
Micro rectification, 1:557
Microseparator
process intensification, 2:855
Microwave dielectric heating, 2:833
Microwave-assisted organic synthesis, 2:836
Minimum ignition energy, 2:923
Minimum ignition temperature, 2:923
Minimum required amount of inert gas, 2:914
Miniplant, 2:765
automation stages, 2:767
construction, 2:766
disadvantages, 2:768
miniaturization limits, 2:767
Mixing
in biochemical engineering, 1:96
in fluidized beds, 1:389
horizontal, of solids, 1:391
hydraulic, 1:98
of gas in bubbling fluidized beds, 1:393
of gas in circulating fluidized beds, 1:393
macermixing, 1:22
micromixing, 1:28
pneumatic, 1:98
in stirred tank reactors, 1:628
time to blend, 1:629
vertical, of solids, 1:390
Mixing principles, 2:849
Model reactor, 1:179
Molecular design
process intensification on phase level, 2:817
Molecular diffusion, 1:32
Molecular dynamics simulation
process intensification, 2:812
Monode equation, 1:20
Monod model, 1:88
Monte Carlo simulation
process intensification, 2:812
Moving bed, 1:378
MRF-Z radial flow reactor, 1:327
MultiPak technology, 1:617
Multiphase reactor concepts, 2:600
Multiple-hearth furnace, 1:445
roasting of sulfide ores in, 1:447
tungsten slag oxidation in, 1:448
vanadium production in, 1:448
Multiple Reference Frame model (MRF), 1:639
Multiple stage flash (MSF), 2:697
Multiplicty
of steady states, 1:76
Multitubular reactor
characteristic numbers, 2:854
MUSIG model
bubble columns, 1:238
N
Nafion membrane, 1:429
Nanotubes
process intensification, 2:864
Natural gas
fuel, 2:728
Nernst’s law, 1:36
Net present value (NPV)
energy management, 2:689
Neural network models
in metallurgical processing, 1:166
Newtonian fluid
stirred tanks, 1:626
Newton–Raphson method, 1:215
Newton number (power number)
for stirred tanks, 1:626
Non-Newtonian fluid
stirred tanks, 1:626
Noranda furnace, 1:452
Notification of Installations Handling Hazardous Substances (NIHSS) Regulation, 2:977
Nozzle plate
in fluidized-bed reactors, 1:379
Nusselt correlations, 1:546
Nusselt number
for gas-evolving electrodes, 1:287

O
Occupational exposure limits (OEL), 2:935
application of, in electrothermal furnaces, 1:458
for three-dimensional electrodes, 1:294
Organized structures radiation model, 2:1067
Overpotential
in gas-evolving electrodes, 1:287
Oxygen uptake rate, 1:90

P
Packed-bed reactor, 1:198
bed porosity of, 1:203, 1:656
energy balance, mathematical treatment of, 1:199
mass balance, mathematical treatment of, 1:199
mass transport in, 1:204
mathematical treatment of, 1:205
Palladium membranes, 1:423
Parallel-plate cell, 1:298
Particle-pellet model
in metallurgical processes, 1:170
Particle size distribution
of bed solids, 1:392
Péclet number, 1:204
Peat
fuel, 2:726
Penetration theory, 1:33
see also Higbie penetration model; Danckwerts penetration model; Surface renewal model; Film theory; Stagnant film model
Penetration time, 1:34
Perfluoroalkanes
process intensification, 2:821
Peristaltic pump
in biochemical engineering, 1:148
Personal protective equipment, 2:959
Pervaporation
in membrane reactor, 1:424
Phase inversion temperature, 1:635
PHAST, 2:1046
Phenol
cumene process vs. direct oxidation with nitrous oxide, 2:800
Photocatalysis
process intensification, 2:832
Photocatalytic membrane reactor, 1:429
Photocatalytic reactor, 2:832
Photosynthesis–irradiance microalgae, 1:484
Pinch analysis, 2:706
Pinch principle, 2:709
Pinch technology, 2:705
cold composite curve, 2:707
energy-capital trade-off, 2:710
grand composite curve, 2:709
hot composite curve, 2:707
Pipe
in biochemical engineering, 1:142
Piston pump
in biochemical engineering, 1:148
Pitched blade turbine, 1:626
Plant and process safety, risk communication
informal procedures, 2:1145
normative procedures, 2:1142
Plant design
energy efficiency, 2:691
Plant information system, 2:700
Plant operation
control design, 2:700
energy efficiency, 2:700
Plasma furnace, 475, 1:456
Plug flow, 1:154
deviations from, 1:158
Plug flow model
in microreactors, 1:602
Plug-flow reactor (PFR)
mathematical treatment of, 1:26–27
schematic, 1:154
Poincaré map
for microreactors, 1:593
Poiseuille flow
in microreactors, 1:599
Polydimethylsiloxane (PDMS) membrane, 1:426
Polymide membrane, 1:427
Poly(N-isopropylacrylamide), 2:824
Polymerization
complex reaction scheme for, 1:16
Polymers
in biochemical engineering, 1:124
Pool fire, 2:1057
bounding materials, 2:1059
large, 2:1062
modeling, 2:1064
Population balance methodology
in metallurgical processes, 1:171
Porous-media model, 1:580
Power number, 1:626
Power law
equation, 1:15
Power number, 1:626
see also Newton number
Power plant
cogeneration, 2:737
combined cycle, 2:738
distributed and centralized, 2:738
pulverized coal, 2:736
thermal, 2:735
turbo generation, 2:737
Prandtl number, 1:235
for gas-evolving electrodes, 1:287
for microreactors, 1:582
Pressure-relief device, 2:997
Process control engineering
control system, 2:987
equipment, 2:988
initiation of safety devices, 2:993
monitoring system, 2:987
operation of safety systems, 2:991
principles of safety systems, 2:990
safety instrumented system, 2:987–988
safety techniques, 2:985
systems, classification of, 2:986
Process design
coupled distillation, 2:715
energy efficient, 2:712
feed-effluent heaters, 2:715
fluid-fluid heat transfer, 2:715
multi-stage designs, 2:714
in reactive distillation, 1:613
steam generation, 2:713
Process development
basic flow diagram, 2:774
chemical plant structure, 2:754
costs, 2:759
criteria for reducing variant numbers, 2:760
cyclical pattern, 2:758
data banks, 2:760
depreciation, 2:782
economic risk, 2:788
energy costs, 2:778
energy management in, 2:689
evaluation, 2:773
expert system, 2:782
feedstock costs, 2:778
fundamentals, 2:749
improving technical reliability, 2:783
integrated trial plants, 2:765
investment, 2:775
ISBL investment costs, 2:776
laboratory experiments, 2:763
microplant, 2:765
miniplant, 2:765
OSB investment costs, 2:777
pilot plant, 2:768
plant construction, 2:768
process flow diagram, 2:775
production costs, 2:778
Pullman–Kellog Millisecond furnace, Public Safety and Emergency Preparedness Canada (PSEPC), Pseudo-steady-state approximation

Propylene oxide
Propylene
Production site management

Process hazard assessment and safety evaluation (PHASE), 2:941
Process intensification

classification, 2:796
comparison of conventional and microplant process, 2:846
constituents of, 2:795
definition, 2:794
micro process technology, 1:499
miniaturization of equipment, 2:845
molecular descriptors, 2:799
at molecular level, 2:797
phase level, 1:821
Process optimization, 2:716
Process Safety Management (PSM), 2:978
Process simulators, 2:716
Production site management
energy efficiency, 2:701
Propane
fuel, 2:728
Propylene oxide
reaction routes, 2:801
Pseudohomogeneous model
in trickle-bed reactors, 1:660
Pseudo-steady state, 1:14
Pseudo-steady-state approximation
in metallurgical processes, 1:170
Public Safety and Emergency Preparedness Canada (PSEPC), 2:979
Pullman–Kellogg Millisecond furnace, 1:670
Pump cell, 1:298
Pyrox process, 1:403

Q
Quantum chemical calculation
process intensification, 2:811

R
Rachette furnace, 1:449
RADFRAC
for simulation of reactive distillation processes, 1:615
Rate-controlling step
in trickle-bed reactors, 1:660
Reaction, chemical

influence of concentration, 1:12
influence of temperature, 1:11
principles of reaction engineering, 1:9
selectivity of reactions in series, 1:42
selectivity of simultaneous reactions, 1:62
Reaction engineering potential

chemical intensification, 1:510
transport intensification, 1:508
Reaction, equilibriuim, 1:13
Reaction kinetics
chemical rates, 1:10
Reactive chromatography
continuous, 2:885
discontinuous, 2:884
Reactive distillation, 1:609
Reactor
degree of reactor utilization, 1:60–61
design equations for model reactors, 1:179
desorptive cooling, 2:875
monolithic, 2:859
optimization of, 1:214
production of biogas, 1:405
sorption-enhanced, 2:886
with three-dimensional electrodes, 1:292
Reason model, 2:1106
Reduction resistance furnace, 1:460
production of carbides in, 1:462
production of ferroalloys in, 1:462
production of lead from sulfide ores in, 1:464
production of matte in, 1:465

slag cleaning in, 1:464
Refining resistance furnace, 1:464
Reporting of Injuries, and Dangerous Occurrences Regulations (RIDDOR), 2:977
Residence time
stirred tanks, 1:637
Residence time distribution
continuous stirred-tank reactor, 1:155
micromixer, 1:531
plug flow reactor, 1:154
of solids in fluidized beds, 1:392
in thin-film reactors, 1:643
Resistance furnace, 1:458
indirect heating, 1:455
production of nickel/ferronickel in, 1:458, 463
with direct resistance, 1:455
Return on investment (ROI)
energy management, 2:689
Reversed-flow reactor (RFR), 1:254
Reynolds–Average Navier–Stokes (RANS), 1:639
approach, 2:1047
Reynolds number, 1:235
in curved channels, 1:576
for fluidized beds, 1:377
for gas-evolving electrodes, 1:285–286
for microreactors, 1:583
in multichannel reactors, 1:580
SAR mixer, 1:598
for stirred tanks, 1:625
for trickle-bed reactors, 1:655
Rhodes and Geldart model
for fluidized beds, 1:382
R–Phases, 2:933
Riser cracker, 1:396
Rising-film reactor, 1:642
Risk
acceptance criteria, 2:1096
analysis, 2:1095
communication, 2:1141
individual, 2:1097
limit values, 2:1089
perception, 2:1139
permit-to-work systems, 2:964
plant life cycle, 2:1143
requirements SIL1 and SIL2, 2:989
requirements SIL3, 2:990
societal or collective risk, 2:1099
Risk Management Plan (RMP), 2:979
Risk management process, 2:1130
Root cause analysis, 2:1107
incident reporting, 2:1109
Rotary kiln
design of, 1:439
ore reduction in, 1:442
production of cement clinker in, 1:442
roasting and calcining in, 1:441
Rotating cylinder, 1:298
Rotating packed bed
process intensification, 2:839
Rushton impeller, 1:97
Rushton turbine, 1:624

S
Saccharomyces cerevisiae
production of ethanol with, 1:405
Safe failure fraction, 2:989
Safety
characteristics derived from explosion diagrams, 2:913
handling of chemicals, 2:960
inherent, 2:1104
maintenance and inspection, 2:1125
plant and process safety, 2:956
production process operation, 2:1122
Safety concept, 2:1008
process control engineering, 2:985
Safety devices, 2:993
Safety integrity level, 2:989
Safety Management System (SMS), 2:972
Safety regulation
Accident Ordinance, 2:976
Canada, 2:979
European Union, 2:969
Germany, 2:975