

Index

a

abrasion 1
 – index 95
 acetic acid 11, 195
 acetic acid anhydride syntheses 6
 activation energy 61, 64, 138, 139
 Aerojet Rocketdyne compact gasifier 224
 agglomeration 2, 40, 44, 47, 75, 86, 93, 94, 98,
 113, 114, 147, 237, 242, 294, 305, 331, 336,
 337, 348
 – behavior of an unknown coal 47
 – fine coal and the high-ash content 2
 – fluidized-bed gasifier 75, 239
 – particle residence times at high
 temperatures 335
 – particle size 338
 – selective 119, 120
 alkaline metals 54
 allothermal process type, gasification reactions 108
 ammonia 4, 10, 11, 14, 19, 51, 170, 171, 195,
 229, 255, 256, 264, 267
 – generation from coal 51
 – world production 16
 ammonium chloride 53
 ammonium sulfate 50
 anthracite 28, 31, 32, 39, 42, 43, 45, 70, 74, 94
 Arrhenius approach 137, 139
 arsenic 14, 19, 70, 71, 85, 215
 ash agglomeration. *See* agglomeration
 ash behavior 1, 26
 ash component
 – analysis 72, 73
 – catalytic active 62, 69
 ash cooling 230, 338
 – configurations in lower moving bed 341
 ash fusion analysis 73
 – ash clinkering test 75, 76
 – ash fusion test 73–75
 – influence of ash compositions 76

– alkali-metal-rich systems 78, 79
 – general remarks 79
 – prediction of ash fusion behavior 79
 – selection of fluxing agents 77, 78
 – typical bulk ash systems 76, 77
 – influence of atmosphere 76
 ash fusion behavior 40, 68, 76, 114, 172, 173,
 245, 258, 273, 304, 316
 – abnormal and unstable 86
 – of different solid fuels 115
 – prediction of 79
 – under reducing atmosphere from coals of
 different rank 74
 ash melting temperature 9
 ash properties, utilization 86
 ash yield 1, 40, 42, 173, 312
 autothermal process type, gasification
 reactions 108

b

ballast coals 40
 bed type (particle size), gasification
 methods 112
 – entrained-flow gasifiers 114
 – fluid-bed gasifiers 113, 114
 – moving-bed gasifiers 112, 113
 Bharat Heavy Electrical Limited
 Technology 243
 bituminous coals 2, 29, 39, 40, 41, 45, 58, 70, 74,
 89, 94, 119, 143, 177, 188, 204, 217, 242, 259
 blends 4, 27, 32, 33, 90, 116, 203, 248
 – identification 30
 boiler feed water (BFW), exergy balancing 324
 boric acid 50
 Boston–Mathias modifications 342
 Boudouard reaction 118, 324
 British Gas/Lurgi (BGL) system 263, 299
 – development plants 265
 – enhancements 275

- historical background 263, 264
 - operational data 275, 276
 - operational problems 274, 275
 - process control 273, 274
 - process description 264
 - basic principle 264
 - coal distributor and stirrer 269, 270
 - fluxing agents addition 269
 - fuel specification 266, 267
 - gas generator vessel 268, 269
 - gas outlet 270
 - processes in moving bed 267, 268
 - raceways and slag bath 268
 - slag discharge 271
 - slag quench chamber and discharge 271, 272
 - tar removal and recycling 272
 - Tuyère nozzles 270
 - wash cooler and waste heat boiler 272
 - process performance 273
 - slagging gasifier 266
- C**
- caking coals 9
 - caking properties 57
 - dilatation test (Audibert-Arnu) 59
 - free-swelling index 58
 - Gray–King assay 57, 58
 - plastic properties of coal 58
 - Roga index 58, 59
 - caking tests 27
 - capital costs 10
 - for coal-based syngas generation 9
 - carbon (graphite) 55
 - capture and storage 12
 - conversion 1, 5, 59, 64, 69, 111, 114, 124, 135, 179, 181, 203, 205, 219, 224, 229, 235, 263, 290, 292, 330, 333, 343, 351
 - encapsulation 1
 - nonaccessible 299
 - oxygen-to-carbon ratio 53
 - from the ultimate analysis comprises 50, 51
 - carbonaceous materials 35
 - carbonates 1, 35, 50
 - carbon dioxide 50
 - emissions 17
 - free power generation 12
 - generation in a water–gas shift reaction 17
 - carbon disulfide 52
 - carbon monoxide 3, 11, 14, 149, 151, 188
 - shift conversion 328
 - carbonyl sulfide 51
 - catalysts 124
 - activity in process, factors to be reviewed 124
 - catalytic coal gasification 124
 - application 126
 - groups of catalysts 125
 - alkali metals 125
 - alkaline earth metals 125
 - transition metals 125, 126
 - poisoning 52
 - CB&I E-Gas technology. *See* E-Gas technology
 - CFD. *See* computational fluid dynamics (CFD) modeling
 - chemical energy 4
 - Chevron-Texaco technology 193
 - China
 - GE petroleum coke and coal gasifiers in operation 195
 - IGCC plants 12
 - noncaking bituminous coals in 43
 - second generation of coal gasifiers, technologies 5
 - shares of world wide gasification by technology 8
 - Shell and Uhde (Prenflo) coal gasifiers in operation 171
 - SNG market 262
 - substitution of crude oil 6
 - technologies (SEDIN, MCSG, HT-L, and ECUST) 8
 - utilization of coal with elevated ash content 1
 - chlorine 53
 - compounds 50
 - Choren's clean coal gasifier (CCG) 192
 - C-H-O ternary diagram 289
 - circulating fluidized-bed (CFB)
 - combustion 244, 335
 - circulating fluidized-bed technology 244
 - clean coal gasification technology 192
 - clean gas 107, 172, 174
 - coal-adapted kinetic submodel 135
 - coal agglomerates 331
 - coal analyses 36–38
 - conversion factors
 - for different reporting bases adopted from ASTM D-3180 37, 38
 - heating values 37, 38
 - relationship of analytical bases to various coal components 36
 - reporting analytical data 35
 - air-dried (ad) 36
 - as-determined (ad) 36
 - as-received (ar) 36
 - dry mineral matter-free (dmmf) 37
 - water and ash-free (waf) 37

- water-free (wf) 36
 - coal, as gasification feedstock 25, 26
 - coal-based integrated gasification combined cycle (IGCC) power plants 18
 - coal beneficiation processes 9
 - coal blends. *See* blends
 - coal classification 35, 36
 - according to ISO 40, 42
 - ASTM classification of coal by rank 39
 - coal conversion capacity 343
 - coal drying 244
 - coal enthalpy model “HCOALGEN” 323
 - coal exergy flow
 - higher heating value (HHV) basis 326
 - coal gasification. *See* gasification
 - coal gasifiers 4, 5. *See also* gasifiers
 - technologies 6
 - coal heating value, in gas phase 109
 - coal liquefaction 14
 - coal milling, electric energy demand 323
 - coal moisture 25, 44, 45, 54, 109, 161, 162, 249, 314
 - coal preparation, expenditures 1
 - coal price 10
 - coal quality 1, 339
 - coal reactivity 59, 65, 67, 172
 - coal sampling 43
 - with mineral acid 50
 - coal slag viscosity behavior
 - under reducing atmosphere 115
 - coal-water-slurry feeding 17
 - with lower efficiency 351
 - coking 9
 - cold gas efficiencies 5, 292, 293, 297, 302, 306, 313, 314
 - equivalent diagram for 301
 - system coal-oxygen-carbon dioxide, gasification diagrams 315
 - cold gas quench features 325
 - combusting particle, material properties 148
 - combustion 9, 12, 18, 19, 25, 37, 55, 107, 131, 271, 290, 314
 - computational fluid dynamics (CFD)
 - modeling 129, 145
 - background 145
 - case setup, typical 145
 - calculation domain, definition of 145, 146
 - definition of simulation domain 146
 - selected material properties for combusting particle 148
 - solver settings and numerical submodels 147, 148
 - convergence strategies 148
 - internal circulation gasifier case, results for 148–150
 - homogeneous reaction rates in internal circulation zone 150
 - mass source terms due to heterogeneous reactions in internal circulation zone 151
 - temperature (flame) in internal circulation zone 149
 - recommendations for future simulations 150, 151
 - crude tar acids 15
 - crushing 1
- d**
- Dalton’s law 133
 - de-ashing 1, 27
 - defluidization 225
 - degree of coalification 26
 - diesel fuel 4
 - diffusion-controlled regime 172
 - dimethyl ether 11
 - direct reduction of iron ore (DRI) 15, 247
 - discrete phase model (DPM) 147
 - Drawe, Rudolf 5
 - dry-ash moving-bed systems 7
 - dry-fed solid fuels 170
 - dry-feed entrained-flow systems 294, 304
 - dry-feed gasifiers 300
 - dry-feed single-stage entrained-flow process 306
 - dry gas exergy 320
 - molar heat capacity of 321
- e**
- East China University of Science and Technology gasifiers 220, 221
 - eddy dissipation concept (EDC) mixture, material properties 147
 - E-Gas gasification. *See* E-Gas technology
 - E-Gas gasifier 328
 - E-Gas technology 210, 296, 299
 - enhancements 215–217
 - configurations 216
 - historical background 210
 - modeling results 219, 220
 - operational problems 215
 - process description 211
 - basic principle 211
 - fuel preparation 211, 212
 - gas cooling 214, 215
 - performance and control 214
 - reaction chambers, first and second stage 213

- slag removal system 213, 214
 - slurry burner 212
 - process flow diagram 211
 - verification case for model setup 217
 - generic model 217–219
 - operation data 217
 - electricity 12
 - electrolysis 17
 - endothermic reactions 109
 - enhanced oil recovery (EOR) 20
 - enthalpy 37, 54, 55, 91, 109, 131, 157, 321, 323, 342, 343
 - entrained-flow reactors 129
 - equilibrium constant-based approach 134
 - ethanol 15
 - Eulerian-Lagrangian framework 147
 - exergetic analysis
 - gas cooling methods, impact of 324–326
 - gasification systems, comparison of 326
 - flow analysis 326–328
 - process efficiency 328, 329
 - exergetic calculations 319
 - efforts/benefits, definition of 323, 324
 - of gaseous and liquid streams 320–322
 - and reference environment 319, 320
 - of solid streams 323
 - exergy flows 320
 - exinite 26
- f**
- feeding method 116
 - dry feed systems 116–118
 - hydraulic feed systems 118–120
 - influence of slurry solids concentration on 118
 - feedstock 9
 - fine coal 2
 - Fischer assay for coals 48, 49
 - Fischer tar 49
 - Fischer-Tropsch liquids 170
 - Fischer-Tropsch synthesis 13, 14
 - fluid-bed gasifiers 225, 226. *See also* high-temperature Winkler (HTW) technology
 - fluid-bed reactors 129
 - fluid-dynamic properties 95
 - coal bed pressure drop 95, 96
 - fluid bed pressure drop 96, 97
 - minimum fluidization velocity 96
 - technological background 95
 - terminal entrainment velocity 97, 98
 - visualization in Reh diagram 98–100
 - fluxing agents 1, 35, 115
 - formaldehyde 11
 - fuel gas 51
 - fuel preparation 172
 - fuel sulfur compounds 52
- g**
- gas cooling 169, 324
 - exergetic analysis 325
 - methods 319
 - gas exergy 320
 - slurry gasifier points 295
 - gas heating value 12
 - gasification 1
 - applications 3, 4
 - carbon-bearing streams 51
 - challenges and opportunities 16–18
 - commercial attractiveness of products from 10
 - commercially available technologies 7
 - concept advanced, suggestions for 332
 - conversion chain from feedstock to product 4
 - development 351
 - increasing efficiency 351
 - low-grade feedstock, adapting 351
 - overview of 352
 - primary gasification agent nozzle level
 - temperature distribution and velocity vectors 355
 - reducing capital cost 351
 - reliability and availability 351
 - diagrams 298
 - emission of sulfur 5
 - environmental aspects 18
 - air emissions 18, 19
 - greenhouse gases 19, 20
 - pollutants 18, 19
 - solid waste 20, 21
 - water effluents 20
 - fixed-bed dry bottom (FBDB) 1
 - heat supply, type of 108
 - high oxygen purities for 12
 - main markets for 16
 - conversion of carbon to methane during 51
 - parameters 110–112
 - carbon conversion 111
 - cold gas efficiency 110
 - lower heating value (LHV) 111
 - molar H₂/CO ratio 111
 - specific consumptions 111
 - steam decomposition rate 112
 - steam-to-oxygen ratio 112
 - power generation 5

- pressure 5
- projects under development 16
- reactions 108
- shares of world wide technology 8
- syngas
 - combustion 4
 - treatment step 4
- systems
 - balancing of 130, 131
 - coal-oxygen-carbon dioxide for cold gas efficiency and methane yield 315
 - domain boundaries 294
 - thermodynamic process 314, 315
- gasifiers 4
 - classification by bed type 113
 - exergetic process efficiency of 329
 - fixed-bed dry bottom (FBDB) 259, 340
 - fluid-bed zone of 333
 - Hangtian Lu gasifier 193
 - internal circulation (*See* internal circulation gasifier)
 - Kellogg Rust Westinghouse 242, 243
 - Koppers-Totzek 170
 - load reduction 339
 - Lurgi fixed-bed dry bottom 299
 - cold gas efficiency 300
 - Mitsubishi Heavy Industries (MHI) 221, 222
 - moving-bed (*See* moving-bed gasifiers)
 - Pratt & Whitney Rocketdyne 224, 225
 - Shell coal 170
 - single-stage gasifiers approach 169
 - symbols, explanation of 299
 - Thermal Power Research Institute 222, 224
 - two-stage oxygen 208–210
 - utility-gas 237, 238
 - Winkler fluid-bed 5
- gasifying agent 17, 107
 - consumption 319
- Gaskombinat Scharze Pumpe (GSP) 182
- gas mixture, chemical exergy 321
- gasoline 4, 10, 11
- gas purity 9
- gas utilization 10
- GE Energy Technology 8, 193
 - design configurations of GE coal gasification technology 197
 - enhancements 202, 203
 - integration of solids feed pump to gasification technology 203
 - GE coal gasification process with radiant and convective coolers (GE-RC) 196
 - GE gasifier with radiant and convective coolers 198
 - GE petroleum coke and coal gasifiers in operation in 2010 195
 - historical background 193, 194
 - modeling results for GE-Q gasifier 208
 - operational problems 201, 202
 - performance and control 199, 200
 - independent variables 200
 - process description 194
 - basic principle 194
 - fuel preparation 194, 197
 - gas cooling: full water quench 201
 - gas cooling: radiant and convective coolers 200, 201
 - reaction chamber 198, 199
 - slurry burner 197, 198
 - process flow diagram of GE coal gasification process with full water quench 196
 - verification case for model setup 203
 - generic model 204–206
 - modeling results 206, 207
 - operation data 203, 204
- General Electric (GE) Energy coal gasification.
 - *See* GE Energy Technology
- generic models for case studies 152
 - approach temperature concept, limitations of 154, 155
 - boundary conditions 155
 - ash content 163
 - coal characterization 155
 - coal moisture 162
 - coal selection 155, 156
 - gasifier heat loss 160, 161
 - oxygen purity 161, 162
 - preheating 158–160
 - reference case definition 156, 157
 - sensitivity analysis 157, 158
 - slurry conditioning 158
 - modeling approach 153, 154
 - research approach for systematic concept evaluation, steps illustration 153
 - systems selected for study 153
 - sensitivity of investigated parameters to varied boundary conditions
 - summary 163
 - temperature approach concept 152, 153
 - heterogeneous gasification reactions 152
- GE-RC design 328
- German brown coal (lignite B) 40
- Gibbs free energy 134
- Gibbs reactors 341, 342
- grain size 1

- graphite, optimum cold gas efficiency
 - illustration 297
- greenhouse gases 19, 20
- h**
- Haber–Bosch synthesis 10
- Hangtian Lu (HT-L) gasification
 - technology 193
- H₂/CO ratio 11, 192
- H/C ratio 17
- heat balance 131
- heating values 54
 - analysis procedure 54, 55
 - enthalpy of formation 55–57
 - estimation by empirical correlations 55
 - of gases 131, 132
 - technological background 54
- heat of combustion 342
- hematite (Fe₂O₃) 125
- high-ash coals 1, 2, 9
 - South African (SAf) coal 332
- high-ash feedstock
 - fine-grained fractions of 331
- high-pressure reactor
 - entrained-flow processes 332
 - increase in efficiency 332
 - reduction in capital costs 332
- high-quality steam coals 9
- high-sulfur coals 9
- high-temperature Winkler (HTW)
 - technology 226, 333, 346
 - enhancements 233
 - integrated high-temperature Winkler and power high-temperature Winkler 233, 234
 - internal circulation gasifier 234
 - exergetic overview 327
 - fluid-bed flow pattern 300, 339
 - gasification 336
 - historical background 226, 227
 - operational problems 232, 233
 - main sources for outage 232
 - operation reports 338
 - process description 227
 - ash removal system 230
 - average solids properties from 231
 - basic principle 227
 - fuel preparation 227, 228
 - gas cooling 229, 230
 - nozzles 229
 - performance and control 230–232
 - process flow diagram gasification process 227
 - reaction chamber and cyclone 228, 229
 - verification case for model setup 234
 - generic model 235–237
 - modeling results 237
 - operation data 234, 235
- homogeneous methanation 109
- HRL integrated drying gasification combined cycle process 243, 244
- HTW. *See* high-temperature Winkler (HTW)
 - technology
- huminite 26–29
- hybrid-wall entrained-flow gasification 332
- hydrocarbon products 15, 17, 51
- hydrogen 4
 - determination 51
 - generation from coal 51
 - lack of hydrogen in the coal 17
 - organic 51
 - production 14
 - rich gases 12
- hydrogen cyanide 51
- hydrogen sulfide 51
- hydrophobic displacement 120
- i**
- IAPWS-IF97 formulation 321
- incineration 20
- India
 - cold gas efficiency 118, 119
 - Lurgi fixed-bed dry bottom (FBDB) gasifiers in operation 247
 - methanol production 226
 - three-high coals 42
 - utilization of coal with elevated ash content 1
- inertinite 26, 29, 30
- inorganic sulfates and sulfides 50
- integrated drying gasification combined cycle (IDGCC) 244
- integrated gasification combined cycle (IGCC)
 - technology 4, 12, 107, 170, 326, 331
- intermediate pressure (IP) 340
- internal circulating fluidized bed
 - gasifier symbols 306
- internal circulation gasifier (INCI) 145, 295, 332, 346
 - ash removal 340, 341
 - ash-rich coal 332
 - basic principle 333, 334
 - blocks, calculator
 - decomposition block 343
 - dulong block 343
 - heat loss block 343
 - nitrogen block 343
 - oxygen block 343

- results block 344
 - setup block 342, 343
 - solids circulation block 343
 - steam block 344
 - coal gasification
 - process flow diagram 333
 - cold gas efficiency 345
 - cooling 340, 341
 - derived reactor design 345
 - exergetic overview 327
 - expected performance 344, 345
 - feeding 334
 - fuel preparation 334
 - gas cooling 340
 - gasifying agent injection 338, 339
 - O₂ and H₂O consumption 340
 - objectives of 333
 - process control 339, 340
 - process scale-up 345–348
 - reaction chamber
 - fluid-bed zone 334–336
 - moving-bed zone 336, 337
 - particle behavior 337, 338
 - Reh diagram with gasifier operation 337
 - syngas yield 345
 - thermodynamic modeling of
 - block settings 342
 - design specifications 342
 - flow sheet setup 341, 342
 - property method 342
- j**
- Japan
 - coal gasification technologies 7
 - GE petroleum coke and coal gasifiers in operation 195
 - IGCC plants 12
 - power producers accompanied by CRIEPI and 221
 - utilization of coal with elevated ash content 1
- k**
- Kellogg Brown & Root transport reactor 239–242
 - kinetic modeling 135
 - conversion processes 135
 - fundamentals 135–138
 - heterogeneous reaction kinetics 138
 - analysis of kinetic data from literature 138, 139
 - apparent kinetic data for carbon reactions 142
 - intrinsic kinetic data for carbon reaction 140, 141
 - kinetic data for modeling, selection of 139, 143, 144
 - kinetic rate coefficients 143
 - homogeneous reaction kinetics 144, 145
 - kinetic rate coefficients 144
 - Koppers-Totzek atmospheric entrained-flow process 5
- l**
- lignites 27, 29
 - organic sulfur contents 52
 - slurry preparation 169
 - liptinite 26
 - liquid transport medium 109
 - liquified petroleum gasoline (LPG) 15
 - load-change flexibility 331
 - Louisiana Gasification Technology, Inc. (LGTI) IGCC project 210
 - lower heating value (LHV) 343
 - low-rank coals 35
 - low-value/low-grade gasification coals 42
 - Lurgi fixed-bed dry bottom (FBDB) technology 5, 8, 245–247
 - enhancements 261
 - Mark Plus 262, 263
 - Mark V 262
 - Ruhr 100 261, 262
 - historical background 245–247
 - operational problems 260, 261
 - operation data 261
 - of fixed-bed dry bottom (FBDB) gasifiers 259
 - process control 258, 260
 - process description 247
 - ash removal 253, 254
 - basic principle 247
 - coal distribution 251, 252
 - coal feeding 248, 249
 - condensation path of liquid coproducts 254
 - fuel specification 247, 248
 - gas condensation 254, 255
 - gas generator vessel 250, 251
 - gas liquor treatment 255, 256
 - gas outlet 252
 - liquid coproducts of lignite gasification at Vřesová 257
 - moving bed zone pattern 249, 250
 - recycling of liquid streams into the gasifier 256, 258
 - rotating grate 252, 253
 - stirrer 252

- wash cooler and waste heat boiler 254
 - process performance 258
- m**
- macerals 26
 - groups 26
 - property 26
 - marcasite 52
 - mercaptans 52
 - methane 20
 - yield 293, 315
 - methanol 4, 5, 10, 11, 51
 - and derivatives 11
 - stoichiometric number 11
 - world methanol production 16
 - methyl *tert*-butyl ether (MTBE) 11
 - microlithotypes, of different coal ranks 28
 - mineral compounds, devolatilization of 84
 - alkali metals, behavior of 85, 86
 - partitioning 84, 85
 - mineral matter, and ash analysis 1, 68
 - minerals in coal 69
 - coal mineral matter, origin of 69, 70
 - mineral matter in coal, analysis of 71
 - minerals in high-rank coals 70
 - minerals in low-rank coals 70, 71
 - technological background 68, 69
 - transformation 71, 72
 - moderately high ash 1
 - moderators 107
 - moisture content 9
 - moisture exergy 320
 - molar reaction exergies 321, 322
 - molar standard entropies 322
 - molar stoichiometric air demand 322
 - monoethylene glycol (MEG) 15
 - moving-bed gasifiers 244, 245. *See also* British Gas/Lurgi Technology; Lurgi fixed-bed dry bottom technology
 - fine coal, press-feeding of 332
 - moving-bed reactors 129
 - multicomponent slurry gasification (MCSG) technology 6, 7, 209
 - multicomponent slurry gasifier 208
- n**
- naphtha 15, 254
 - natural gas 4
 - natural-gas-based syngas 9
 - natural gas fuel 12
 - nickel 125
 - nitrogen
 - determined in ultimate analysis 50–52
 - nitrogen dioxide 50
 - nonoxidized carbon 51
 - non-slurry systems 327
 - nozzle steam requirements, at various oxygen throughput 339
- o**
- oils 15, 254
 - olefins 11
 - organic sulfur 50, 52
 - oxidant 122, 123
 - oxides of nitrogen (NO_x) 52
 - oxo-alcohols 14
 - oxy-coal plants 314
 - oxygen 52, 53
 - coals with higher oxygen contents
 - gasified, problems 53
 - consumption 1
 - for gasification 107
 - slurry-feed GE 326
 - demand 53
 - influence on a dry-feed entrained-flow gasifier 123
 - oxygen-to-fuel ratio 186
- p**
- Parr formulas 38
 - partial oxidation 107
 - particle size 9, 21, 34, 43, 45, 66, 89, 92, 94, 112, 135, 172, 183, 197, 200, 226, 266, 336, 338
 - petcoke 4
 - petrographic coal analysis 26, 35
 - petroleum coke 4
 - phase inversion-based coal-CO₂ slurry (PHICCOS) feeding system 119
 - phenols 20, 254, 255, 267, 273
 - crude 257
 - physical properties, relevant 86, 87
 - coal density 87
 - apparent density 88
 - bulk density 88, 89
 - true density 87, 88
 - washability test 89, 90
 - granulometric properties 91
 - abrasion index 95
 - fragmentation 93, 94
 - Hardgrove grindability index 94
 - representative diameters 92
 - Rosin-Rammler-Sperling-Bennett (RRSB) particle size distribution 92, 93
 - technological background 91

- thermal properties 90
- – heat capacity 90, 91
- – thermal conductivity 91
- Pittsburgh no. 8 coal diagrams
- approximation equations, coefficients 303
- cold gas efficiency and methane yield diagram 300
- optimum correlations 301–304
- optimum user diagram 301, 302
- syngas yield and H₂/CO diagram 300, 301
- temperature and carbon conversion diagram 298–300
- plug flow approaches 170
- pollutants 18, 19
- polygeneration 4
 - applications 331
- polypropylene 10
- “precombustion capture” technology 12
- Prenflo technology 172
- pressure
 - advantages of pressurized operation 116
 - based expression 138
 - gas turbine inlet pressure 116
 - industrial gasification processes operated at 107
- pressure swing adsorption 14
- proximate analysis 44
 - ash content 44, 46, 47
 - fixed carbon 44, 48
 - moisture content 44
 - – impact on coal-water-slurry feeding 45
 - – impact on dry pulverized coal feeding 44
 - – impact on lump coal feeding 45
 - – natural bed and maximum allowable feed coal moisture 45
 - – technological background 44
 - moisture types 45
 - – air-dried and surface moisture 46
 - – free moisture 45, 46
 - – residual inherent moisture 46
 - volatile matter content 44, 47, 48
- pseudo-Boudouard expression 179, 180
- pulverized coal 50, 172
- “purity” of the coal 27
- pyridine-based compounds 52
- pyrite 1, 35, 52
- pyrite sulfur 50
- pyrolysis 129, 135
 - reactions 109, 110

q

- quartz 1
- quench water 17

r

- radiant syngas cooler 325
- rate-controlling regimes, for heterogeneous reactions 136
- raw gas 107
 - cooling 329
- reactivity 59
 - determination of 60
 - – general considerations 60, 61
 - – spontaneous ignition 67, 68
 - – thermogravimetric analysis 61–67
 - technological background 59
- reasonable modeling approaches 129
- Rectisol 14
- Redlich–Kwong–Soave equation 342
- reflectance
 - interpretation of analysis 31–33
 - maximum 30, 31
 - mean 31
 - measurement 30
- Reh diagram 98, 337
- renewable energy sources 6
- Rosin–Rammler–Sperling–Bennett (RRSB) distribution 147
- rotational-symmetric reactor setup 146

s

- SAf coal. *See* South African (SAf) coal
- salty coals 40, 351
- Sasol dry bottom gasification 263
- SEDIN dry bottom gasification 263
- semi-implicit method for pressure-linked equations (SIMPLE) algorithm 147
- Shell and Uhde coal gasification technology 170, 172
 - basic principle 170, 172
 - coal gasifiers in operation in 2010 171
 - enhancements 176, 177
 - – proposed design enhancements 177
 - fuel preparation 172
 - gas cooling 175, 176
 - historical background 170
 - operational problems 176
 - performance and control 175
 - process flow diagram of Shell coal gasification process 172
 - reaction chamber 172, 173
 - – membrane wall with burner nozzles 173
 - verification case for model setup 177
 - – generic model 178–180
 - – modeling results 180, 181
 - – operation data 177, 178
 - vessel design 173–175

- design configuration of cold gas quench 174
 - membrane wall 174
 - Shell coal gasification process (SCGP) 170
 - Shell cold gas quench 323
 - Shell technology 8, 328
 - Siemens fuel gasification technology 181
 - enhancements 187, 188
 - enhanced gas cooling concepts for the Siemens gasifier 189
 - historical background 181, 182
 - operational problems 187
 - operation data from Siemens gasification 190
 - process description 182
 - basic principle 182
 - burner 185
 - fuel preparation 182–184
 - gas cooling 185, 186
 - performance and control 186, 187
 - process flow diagram 183
 - reaction chamber 184, 185
 - slag removal system 186
 - verification case for model setup 188
 - generic model 188–191
 - modeling results, for Siemens gasifier 191, 192
 - operation data 188
 - slag, utilization properties of 86
 - slag viscosity analysis 79, 205
 - high-temperature viscometer test 79–81
 - prediction of slag viscosity 81
 - critical viscosity 82
 - empirical relationships 81, 82
 - temperature-viscosity curve 82, 83
 - slurry-feed entrained-flow domain 294
 - slurry gasifier evaluation 290
 - solid residue removal 123, 124
 - type/states, and methods 123, 124
 - solid waste 20, 21
 - solvents 1
 - South Africa
 - high-ash coal from 2
 - utilization of coal with elevated ash content 1
 - South African (SAf) coal 332, 337
 - analysis of technology potential 311
 - ash content, influence of 312–314
 - ash-rich 304
 - coefficients for approximation equations 309
 - design and performance parameters 347
 - diagrams for 304
 - cold gas efficiency and methane yield diagram 306
 - optimum correlations 307–310
 - optimum user diagram 307
 - syngas yield and H₂/CO diagram 306, 307
 - temperature/carbon conversion diagram 304–306
 - gasification diagrams 305
 - gasifier layout depending on pressure 347
 - optimum user diagram 308
 - technology potential analysis 310–312
 - spontaneous ignition 35
 - steam coals 1
 - steam consumption 5
 - steam-to-oxygen ratio 112, 297, 301
 - steam-to-oxygen-velocity ratio 338
 - stirred tank reactor 170
 - subbituminous coal 10, 27, 39, 45, 57, 67, 89, 94, 139, 175, 210, 242
 - substitute natural gas 12, 13, 126
 - sulfate sulfur 50
 - as indicator for weathering of coal 52
 - sulfur compounds, recovery 52
 - sulfur determination 50
 - sulfur, forms in coal 50
 - sulfur oxides 50, 52
 - syngas 5, 107
 - cooling 121
 - methods 122
 - H₂/CO ratio 17
 - methane yield of 303
 - yield 293, 297, 302
 - synthesis gas. *See* syngas
 - synthetic natural gas (SNG) 10, 12, 13, 210
- t**
- tar 15, 51, 254
 - production 5
 - temperature
 - coal slag viscosity behavior under reducing atmosphere 114, 115
 - estimation using optical reflectance 33, 34
 - during gasification of solids 114
 - moderating steam 109
 - no-go zone/sticky ash zone 114, 115
 - of sintering or initial deformation, softening 114
 - ternary gasification diagram 289
 - basic idea 289, 290
 - development of 290
 - diagram types 292, 293
 - displaying gasifiers, with multiple inlets 296
 - domain boundaries 293–295

- domain overview/pressure sensitivity 290–292
 - gasifier models, interplay of 295
 - H₂O stream, treatment of 295, 296
 - optimum user diagrams 296, 297
 - pressure sensitivity 291
 - variable combination 293
 - for varying ash content 313
 - TGA. *See* thermogravimetric analysis (TGA)
 - thermal history, of coal 27
 - thermodynamic modeling 131
 - equilibrium constant-based calculations 131–134
 - Gibbs free energy, minimization of 134, 135
 - thermogravimetric analysis (TGA) 48, 61–67
 - carbon dioxide reactivity values 65
 - data analysis 62–65
 - entrained particle reactors 66, 67
 - fixed-bed reactors 65, 66
 - preparation of experiments 61, 62
 - typical application 61
 - wire-mesh reactors 67
 - thermomechanical exergy 323
 - thiophenes 52
 - three-high coals 42
 - properties 42, 43
 - turbulent plug flow profile 336
- u**
- ultimate analysis–measuring procedure 49
 - analysis procedure 49, 50
 - carbon 50, 51
 - chlorine 53, 54
 - hydrogen 51
 - nitrogen 51, 52
 - oxygen 53
 - sulfur 52
 - technological background 49
 - United States
 - bituminous coals from 70
 - coal gasification technologies 7
 - efforts to reduce CO₂ emissions 6
 - IGCC plants 12
 - urea 11, 51
 - utility-gas (U-Gas) process 294, 336
 - agglomerates from 336
- v**
- viscosity 68, 80, 197
 - critical 80, 82
 - inhomogeneous 271
 - kinematic 96, 97
 - of slag 79, 114, 115, 205, 269
 - temperature-viscosity curve 82
 - vitrinite 26–29
- w**
- Wabash River IGCC 210
 - technology, changes of ownership 210
 - wall type gasifier 120, 121
 - cooling screen 120, 121
 - refractory lining 120
 - water jacket 120, 121
 - water effluents 20
 - water-gas shift 109
 - Wobbe index 12
 - wüstite (FeO) 125
- x**
- x-ray spectroscopy 50
 - xylite 27
- z**
- zero-dimensional models 129

