

Subject Index

Note: page numbers in *italic* refer to figures and tables.

- absorption technologies 20, 102–5
- acetate-producing bacteria 77, 80
 - pathway to methane 85–8, 115–16
- algae 136
- anaerobic digestion 82–3
- Archaeobacteria 77, 78
- bacteria
 - cultivation/medium
 - selection 8–11, 90–1
 - ethanol producing 6–9
 - methanogenic 75, 77, 78, 79
 - metabolism 81–5
 - water-gas shift 80–1
- biodiesel
 - background and overview
 - current production
 - processes 134
 - enzymatic production 2, 174, 176–7, 182–4
 - feedstocks 134–7, 141, 151
 - fuel standards 172–3, 175
 - enzymatic/lipase-catalysed
 - processes 137–41
 - immobilised *Candida* lipase for methanolysis 147–8
 - immobilised *Rhizopus oryzae* cells for methanolysis 148–9
 - jatropha oil alcoholysis 141
 - rapeseed oil
 - transesterification 142–3
 - Rhizopus oryzae*
 - transesterification 144–5
 - soybean alcoholysis 141–2
 - sunflower oil alcoholysis 143–4
 - novel enzymatic biodiesel
 - basic reaction routes 149–55, 176–8
 - enzyme selection 155–7
 - methodology 157–9
 - results and conclusions 159–72
 - transportation fuel applications
 - enzymatic biodiesel
 - feasibility 174–6
 - fuel standards 172–4
- biofilms *see Clostridium ljungdahlii*
- biogas *see* natural gas
- bioreactor types 20–3, 92–4
- bubble reactor 21–3, 93–4
- Candida antarctica* 139, 142, 144, 147–8, 156, 157
- Candida rugosa* 138, 146
- castor oil 136
- catalytic tar removal 18, 101
- chemical absorption 102
- Choren gasifier 15, 16
- Clostridium ljungdahlii* 6–9, 66, 85
 - biofilm
 - cell attachment and growth 31–4
 - CO conversion to ethanol 34–7
 - low pH effects 37–41

- Clostridium ljungdahlii* (continued)
 modified medium tests 41–8
 thickness estimation 26, 29
 culture mediums 8–11, 32
 coconut oil 137, 150
 compressed biogas 111
 copra 137
 corn oil 135, 136
 Coskata reactor 93
 COSYMA system 100
 cottonseed oil 135, 137
 cryogenic purification 105, 107
- dehydration technology 53–8
 distillation systems 51–3
- entrained-flow gasification 14
 enzymatic biodiesel *see* biodiesel
 enzymatic hydrolysis 4–5
 enzymatic transesterification *see*
 lipase-catalysed
- ethanol biosynthesis
 background and overview 1–2,
 66–9, 181, 183
 current production and
 usage 3–4, 64
 syngas routes compared 4–6
- basic reactor design and
 methodology 28–31, 68
 CO conversion rate/net energy
 efficiency 27
 mass transfer calculations 23–7
- batch/closed bottle
 experiments 45–8
- biofilm
 attachment and growth 31–2,
 50–1
 test with CO as only C-source
 43–5
- CO conversion 34–7
 closed bottle tests 45–8
 mass-transfer coefficient
 test 48–51
 pH effects 37–9
 dilution rate and product
 concentration 45
- medium tests 41–3
 ethanol distillation/dehydration 51–2
 energy use and efficiency 52–3,
 58–64, 68
 ethanol–petrol blends 64–6, 67
- fatty acid methyl esters (FAME) 131,
 169
- feedstocks
 for biodiesel 134–7, 141, 151
 for ethanol 3–5
- fermentation
 bacterial *see* bacteria
 yeast 4–6
- fermentors *see* bioreactor
- Fick's law 26
- fixed-bed gasification 12, 13
- flow patterns 23–4
- fluid-bed gasification 12–14
- fuel, vehicle
 biogas/SNG 111
 diesel/biodiesel standards 172–4
 ethanol–petrol blends 64–6, 67
- gas cleaning technologies 15–20
- gas flow patterns 23–4
- gasification
 gasifier types and
 techniques 12–15
 and syngas composition 97
 reaction schemes for wood
 oxygen-blown gasifier 114
 steam-blown gasifier 112–13
 simulation of process
 efficiencies 121
- glycerol
 as by-product of biodiesel
 133–4
 enzymatic conversion to
 monoglycerides 149–55, 176–7
- Guessing gasifier 15, 68, 97, 99–100,
 115, 121
- hemp oil 136
- jatropha oil 135–6, 141

- lipase-catalysed
 - transesterification 137
 - lipase immobilisation techniques 145–7
 - lipase types and sources 138–41, 156
 - processes reviewed 141–5
 - immobilised lipase systems 147–9
 - route for low-glycerol biodiesel 149–50, 153–5
 - monoglyceride production 150–3
- Lipozyme* lipases 143, 144
- liquid flow patterns 23–4
- liquid–gas membrane reactor 21, 93
- MDEA (methyldiethanolamine) 20, 102
- membrane technologies 21, 22, 105–7
 - ethanol purification 54–8, 60, 62, 63
- methane biosynthesis
 - background and overview 73–4, 182
 - biological vs catalytic pathways 74–5
 - bacteria strains
 - acetate-producing 77, 80, 85
 - methanogenic bacteria 75, 77, 78, 79, 83–4
 - water-gas shift 80–1, 85
 - cultures and systems
 - co-cultures/indirect acetate pathway 85–8
 - metabolic routes 83–5
 - tricultures/direct methane-producing 88–91
 - product-gas purification 102–7
 - SNG quality demands 107–11
 - reactor selection 94–7
 - syngas composition and quality 97–102
 - wood to SNG feasibility study 111–12
 - biological pathways 124, 125
 - compared with catalytic route 120–2
 - direct triculture design 116–18
 - indirect acetate design 115–16
 - economic analysis 123–5, 127
 - gasifier selection 115, 116–17, 125
 - reaction schemes 112–14 and syngas cleaning 116, 117, 125
 - mass balance and energy efficiency 118–20, 126–7
 - summary 125–7
- Methanobacterium formicicum* 77, 79, 96, 125, 126
 - reaction pathways 82, 86, 88–9
- methanogenesis 82–5
- methanogenic bacteria 75, 77, 78, 79
- Methanogenium frigidum* 83
- Methanopyrum kandleri* 83
- Methanosarcina barkeri* 77, 96, 115, 116, 125, 126
 - reaction pathways 82, 86, 88, 90
- Methanotherix soehngenii* 86, 87, 115, 116, 126
- microbubble reactor 21–3, 93–4
- molecular sieves 53–4, 55, 61, 63
- monoglycerides 149–55, 176–7
- monolith bioreactor 20, 21, 92
 - experimental/lab-scale design 28–30
- multiple-stage gasification 14–15, 16
- mustard oil 135, 136
- natural gas 107, 110–11
 - see also methane biosynthesis; synthetic natural gas
- Novozym* lipases 143, 147–8, 149, 156
- oil washing (OLGA) 18, 101–2
- oxygen-blown gasifier 114
- packed-bed reactor 21, 92
- palm oil 136, 150

- peanut oil 135, 137
Peptostreptococcus productus 80, 82, 85, 94, 125, 126
 pervaporation 55, 56, 57–8
 petrol–ethanol blends 64–6
 physical absorption 102
 porcine pancreatic lipase 153–5, 161–2, 163
 pressure-swing adsorption 103–5
 PS30 lipase 140
Pseudomonas cepacia 139, 141, 146, 152
Pseudomonas fluorescens 138, 143–4, 145–7, 152
- radish oil 136
 rapeseed oil 135, 136, 142–3
 Rectisol process 20, 102, 103
Rhizomucor miehei 138, 157
Rhizopus oryzae 144–5
Rhodopseudomonas gelatinosa 80, 85–6
Rhodospirillum rubrum 80, 96–7, 99, 118, 125
 reaction pathways 81, 85–6, 88, 90
 rice bran 137
Rubrivivax gelatinosus 80, 81
- safflower oil 135, 136
 SNG *see* sythetic natural gas
 soybean oil 135, 136, 141–2, 148–9
 steam-blown gasifier 112–13
 sunflower oil 136, 143–4, 153, 156
 syngas
 bioconversion *see* ethanol
 biosynthesis; methane
 biosynthesis
 composition and
 contaminants 15–17, 97–9
 purification 17–20, 68, 99–102, 125
 see also gasification
 synthesis gas *see* syngas
 sythetic natural gas 73–4, 76
 biosynthesis of *see* methane
 biosynthesis
 purification technologies 102–7, 108, 109, 118, 126
 quality demands 107, 110–11
 as vehicle fuel 111
- tar removal 17–18, 101–2
 Taylor-flow 24, 26
Thermonyces lanuginosus enzyme 156, 157
 in biodiesel experiments 159–76
 transesterification 133–4
 see also lipase-catalysed
 transesterification
 trickle-bed reactor 20, 21, 92
 experimental/lab-scale
 design 28–30
 triglycerides 134–5
- vacuum pressure-swing
 adsorption 103–5
 vapour phase permeation 55, 56, 57
 vegetable oil feedstocks 134–7, 141, 151
 venturi absorbers 23
- water-gas shift bacteria 80–1
 wet scrubbing 17–18, 101
 whale oil 137
 wood gasification 68, 112–14
 yeast fermentation 4–6