

Index

a

- abnormal combustion symptoms 383, 384
- absolute vapor pressure 516
- absorption method 125, 126, 147
- absorption process 107, 126
- acidity method 222
- active recirculation 454
- additives
 - biocides 521
 - corrosion inhibitors and lubricity improvers 520–521
 - metal deactivators 520
 - oxidation inhibitors 520
 - thermal stability additives 521–522
- adiabatic reactors 257
- adsorptive purification 109
- air supply system 452–453
- aircraft fuel systems 514–517, 520–522
- airport fuel-handling equipment 517
- Alcohol Motor Fuel Committee 21
- alcohol-fueled engines 20
- alcohols, densities of 423
- algal biofuel technology 325
- algal oil production 326
- alkaline fuel cell (AFC) 447
- alkaline-earth elements 479
- alkyl lead compounds 10, 404, 410, 412–414, 417
- alkylate 92, 427
- alkylation 9, 104, 107, 404, 415, 426
- alumina 105, 109, 125, 279, 479
- ambient temperature oxidation 514
- amine absorption process 126
- anaerobic fermentation 145–146
- anti-icing additives 10, 517, 521
- anticorrosion properties 81, 84
- antiknock effect 8, 409, 410, 413, 423
- antiknock index (AKI) 407, 414
- aromatic-rich fuel 414
- ash content 330, 539, 540
- ash load 493
- ashless octane enhancers
 - heteroatom-based components
 - history of fuel oxygenates 417–420
 - production 424–426
 - properties of oxygenates 420–424
 - toxicology 426–427
- asphaltenes 540
- ASTM D 86 distillation curve 227
- ASTM fuel ethanol specifications 221, 223
- ASTM International 182
- Atkinson-cycle engine 13
- autoignition temperature 84, 136, 141, 378, 381, 386
- automobile exhaust control
 - carbon dioxide 473
 - CO 471
 - hydrocarbon 471–472
 - oxidization of NO 472
 - particulate emission 472–473
 - sulfur compounds 473
- automotive emission control 501
- automotive fuel 1, 13, 22, 24, 26, 52, 60, 112, 129–141, 152, 154, 230, 273, 332, 351, 357, 453, 529

- autothermal reforming (ATR) 163, 169, 254–256, 327, 375
- aviation fuel
 - alternative jet fuel components 525
 - annual Avgas consumption 529
 - Avgas 102 530
 - Avgas 100LL 530
 - Avgas 100VLL 531
 - Avgas UL82 531
 - Avgas UL87 531
 - Avgas UL91 531
 - bulk properties
 - combustion 512–513
 - density 507
 - elastomer compatibility 513
 - low temperatures operability 513–514
 - specific energy 507–512
 - volatility 512
 - economic aspects 523–524
 - environmental aspects 523
 - handling, storage, and transportation 522
 - history 505–530
 - legal aspects 523
 - nonspecification properties
 - absolute vapor pressure 516
 - lubricity 517–518
 - water miscibility 517
 - petroleum-derived fuels 524
 - production 518–522
 - specification requirements 507
 - trace properties
 - corrosion 515
 - oxidative conditions 514
 - static electricity 516
 - water separation 515–516
- b**
- Ball-on-Cylinder Lubricity Evaluator (BOCLE) ASTM D 5001 518
- battery electric vehicle (BEV) 56, 61, 459
- bifueled vehicles 135, 207
- biocides 521
- biodiesel (FAME) 25–28
 - analytical methods
 - acid number 329
 - alcohol content and flash point 329–330
 - alkaline and alkaline-earth metals 331
 - ester content and fatty acid composition 326–327
 - glycerol and glyceride content 328
 - iodine value 329
 - oxidative stability 331
 - oxide ash 330
 - polyunsaturated methyl esters content 327–328
 - sulfated ash 331
 - sulfur and phosphorus content 331
- emissions 345
- engine deposits 344–345
- fuel lubricity 343
- fuel properties
 - cetane number 334
 - density and energy content 339
 - distillation 341
 - filterability 341
 - kinematic viscosity 339, 347–348
- fuel stability 341–342
- fuel standards 350–351
 - ASTM D 6751 332
 - ASTM D 6751 standard 332
 - ASTM D 7467 333
 - ASTM D975-2019A norm 333
 - ASTM International 332
 - B100 specifications 332
 - CONCAWE guideline 334
 - EN 14214 333
- history of 317
- HVO fuels 363–366
- hydrogenated vegetable oils
 - basic chemistry of 351–352
 - EN 15940 standard 351
 - fuel standard and properties 354–357
 - process 352–354
 - production plants 354
- material compatibility 343–344
- national mandatory limits 316

- production
 - acid catalysis 320
 - alkali hydroxides 319
 - basic or acid catalysis 319
 - feedstock 322–324
 - homogeneous catalysis 319
 - in-situ transesterification 320
 - industrial production 321
 - inhomogeneous system 318
 - methyl esters 318
 - microalgae 324–326
 - organic bases 319
 - phase separation 319
 - saturated and unsaturated fatty acids 318
 - transesterification reaction 318
- production free fatty acids 319
- total contamination 343
- types of 316
- vegetable oils (VO) 345–351
- vehicle adaptations 316
- water content 343
- WTT analysis 359–361
- WTW analysis 361–363
- biodiesel market 317
- biodiesel producers 27
- biodiesel sales 317
- biodiversity 219
- bioethanol
 - biodiversity 219
 - brazil 208
 - in China 209, 211
 - corrosion protection 228–229
 - denaturant and denaturant content 229
 - emissions 229–230
 - energy content 228
 - ethanol concentration 213–214
 - in Europe 209
 - eutrophication and acidification 219
 - feedstock 214–215
 - fermentation of glucose 213
 - flex-fuel vehicle engines (FVV) 207
 - flexible-fuel vehicle 207
 - fuel properties 224–230
 - fuel standards 221–224
 - heat of vaporization 228
 - land use 215–217
 - lignocellulose 220–221
 - lubricity 229
 - material compatibility 229
 - nitrogen oxide emissions 217–218
 - octane numbers 224–226
 - production 210–214
 - soil quality/erosion 219
 - starch/maize mash processing 212
 - straw 231
 - sugar beet 230–231
 - sugarcane 231, 236
 - USA 208–209
 - volatility and distillation 226–227
 - water content 228
 - water footprint (WF) 219
 - wheat grain 231
 - WTT analysis 236–237
 - WTW analysis 237–240
- biohydrogen 375
- biomass-to-liquids (BTL) 315
 - biodiesel (FAME) 315
 - biomass gasification 169
 - Carbo-V gasification process 168
 - Choren BTL process 168
 - Choren process 169
 - energy requirement of 168
 - Fischer–Tropsch synthesis 164–165
 - fuel characteristics
 - cold flow performance 174–175
 - combustion properties 170
 - EN15940 and test methods 171–172
 - injector cleanliness and spray characteristics 174–175
 - lower density 171
 - lubricity performance 174
 - synthetic fuels for emission control 175–178
- biomethane
 - chemical absorption 148
 - compressed biomethane (CBM) 155
 - cryogenic separation 149
 - distribution 150
 - financial incentives 142
 - membrane separation 148–149
 - physical approaches 142

- biomethane (*contd.*)
 pressure swing adsorption 149
 production
 anaerobic fermentation 145–146
 biogas 146–147
 ethanol technology 142
 food processing wastewaters 143
 post-production treatment 144
 production pathways 144–145
 residual sludge 143
 properties 142
 Regulations and Standards 151–152
 storage 149–150
 water scrubbing and physical scrubbing 147
 well-to-tank analysis 152–155
 well-to-wheels analysis 156–158
 biomethane (MSW) 147
 blending octane number (BON) 407, 408, 421–423
 Blowby gas 383, 385
 boiling range 14–16, 84, 85, 93, 165, 203, 276, 403, 512, 518, 519
 boiling water reactors 257
 Boyle, ROBERT 24
 brake specific fuel consumption (BSFC) 438
 brakethermal efficiency 386
 British foreign policy 21
 Buna-N rubber (NBR) 186
 Butane 28, 29, 31, 90–92, 101–104, 107, 109, 110, 112, 115, 122, 125, 129, 132, 165, 183, 265, 278, 403, 424
 Butanol 142, 224, 278, 309, 416, 422, 425
- C**
- Calculated Carbon Aromaticity Index (CCAI) 538
 Calculated Ignition Index (CII) 538
 Carbo-V gasification process 168
 carbon dioxide 24, 34, 43, 78, 103, 105, 122, 126, 132, 145, 147, 149, 186, 190, 211–213, 222, 271, 273, 276, 292–297, 326, 353, 391, 468, 473, 475
 carbon monoxide 11, 34, 78, 163, 263, 271, 311, 345, 353, 391, 417, 451, 467, 471, 512, 523
 Carbon Recycling International 166
 carbon-capturing 468
 carrier oxide surface 479
 catalyst cars 79, 80, 458
 catalyst production processes 480–481
 catalytic converters 11, 48, 70, 387, 405, 467
 catalytic cracking 9, 90, 92, 102, 104, 278, 413, 519
 catalytic material 319, 480
 catalytic reforming 101, 102, 104, 142, 404
 catalytically cracked gas oil 94–95
 caustic soda treatment 109
 central point injection (CPI) 139
 ceramic monolithic-based converter 477
 ceramic monoliths 477
 cerium oxide 479
 cetane index method 82
 cetane number 25–26, 73, 82, 84–85, 93, 94, 96, 170, 171, 175–176, 183, 188–189, 249, 281, 283, 284, 287, 297, 318, 323, 338, 345, 348, 353, 356, 537
 Chevrolet Electrovan 447, 448
 Choren BTL process 168
 C₅ hydrocarbons 265, 422, 423
 Clean Air Act 28, 41, 45, 276, 417
 clean air act amendments (CAAA) 41, 417
 closed filters 493
 closed photobioreactors 324, 325
 CO₂ emissions 2, 34, 36, 37, 39, 46, 81, 114, 170, 178, 192, 193, 196, 266, 294, 345, 358, 432, 468, 473, 501
 coal-based processes (CTL) 58, 162–164, 191–193, 195, 202, 354
 coating procedures 480
 cobalt-based catalyst 165
 coking 10, 91, 167, 328, 522
 cold filter plugging point (CFPP) 83, 165, 166, 175, 332, 538

- cold temperature 25, 28, 39, 226, 227, 309, 334, 339–341, 356, 497
 - combined processes 107
 - combustion chamber design 12, 523
 - combustion engine 4, 5, 29, 61, 69, 135, 161, 178, 207, 261, 289, 395–397, 416, 431, 433–440, 443, 447, 449, 454, 456–458, 467, 468, 471, 472, 536
 - combustion engine vehicles 467
 - combustion products 83, 196, 266, 409, 410, 413, 471
 - Commer engine 15
 - commercial aircraft 505
 - commercial aviation 506, 524
 - common rail direct injection 17
 - compressed biomethane (CBM) 149, 150, 155
 - compressed natural gas (CNG) 31, 60, 138
 - CNG options 154
 - tank filling 122
 - compression stroke 405
 - compression-ignition (CI) engines 472
 - compressor oil contamination 132
 - Conductivity Improving Additives 520
 - conventional catalysts 501
 - conventional petroleum-derived fuels 25
 - conventional process 250, 480
 - conventional three-way catalyst 494, 501
 - cooling circuit 454
 - Cooperative Fuel Research (CFR) engine 76, 82, 225, 406, 421
 - Cooperative Fuel Research (CFR) single-cylinder engine 406
 - corrosion 10, 81–84, 86, 97, 124, 126, 149, 151, 183, 221, 228–229, 266, 268, 414, 416, 515, 517, 520–521, 539
 - corrosion protection 228–229
 - cradle-to-cradle 55
 - cradle-to-gate 54
 - cryogenic fuels 525
 - cryogenic separation 147, 149
 - cyclization 9
- d**
- Daimler single-cylinder engine 4–5
 - dedicated CNG vehicles 135
 - defeat device 40
 - density 82, 83, 309, 334, 339, 348–349, 355, 423, 507
 - detonation 376, 388, 392
 - Deutz factory 3
 - diesel combustion process 14, 82, 93
 - diesel engine 1, 15–17
 - combustion chamber 72
 - common rail technology 72
 - direct injection 63, 71
 - direct injection engines 72
 - four-stroke engines 71
 - fuel and engine parameters ignition 71
 - history of 14–18
 - precombustion chamber processes 72
 - self-ignition 71
 - diesel fuel 1, 14–18, 82–86, 93–96, 161–196
 - diesel oxidation catalyst
 - NO oxidation 490
 - particulate emissions 490
 - particulate filter regeneration 490
 - Pt/Pd dispersion 491
 - SO₂ 490
 - diesel oxidation catalyst (DOC) 176, 475, 489–490
 - diesel, RUDOLF 1, 14, 19, 24
 - diethanolamine (DEA) 126
 - diglycerides (DG) 318, 328
 - diisopropyl ether (DIPE) 422, 426
 - diluents 390, 391, 540
 - dimethyl ether (DME) 60, 249, 279–281
 - fuel properties 183–186
 - fuel standards 181–183
 - fuel uses 187–189
 - infrastructure and safety 186–187
 - physical properties of 180
 - 2,5-dimethylfuran (DMF)
 - advantages 309
 - combustion and emissions 311–312
 - properties of 309–310

- 2,5-dimethylfuran (DMF) (*contd.*)
 synthesis of 307–308
- direct cylinder injection 376, 383, 389
- direct injected engines 43, 70
- direct injection gasoline engines 265, 500
- direct injection technology 12, 228
- Direct Land Use Change Emissions (DLUC) 57, 215, 217
- direct methane oxidation 261
- distillate fuel 327, 332, 333, 341, 343, 535–537
- distributor pump direct injection 17
- double-bed design 484
- dual-fuel (heavy-duty) diesel engines 135
- dual fuel technology 139
- dual-fueled vehicles 136
- Duffy, E. 26
- DW10 industry standard test 175
- e**
- elastomers 81, 181, 185–187, 229, 265, 268, 286, 343, 357, 513, 514, 524
- elastomer compatibility 513
- electrochemical solid-state sensors 485
- electrolysis 61, 63, 144, 170, 249, 259–261, 294, 296
- Electronic Stability Control (ESC) system 438
- Elsbett engine 25
- emission control catalysts 476
- emission legislation 41, 468
- emission regulation, in Europe 467–468
- emissions 345, 357
 China 51–53
 Europe 35–40
 Japan 48–51
 United States 41–48
- EN 14105 328, 329
- energy consumption 39, 63, 113, 147, 263, 345, 363, 451, 454, 459
- energy content 57, 122, 132, 149, 154, 196, 228, 231, 281, 297, 309, 334–339, 349, 355, 359, 366, 378, 524, 540
- energy density 113, 167, 170, 188, 248, 288, 309, 385, 394, 431, 442
- energy management 441, 443–444
- engine combustion performance 513
- engine condition 405, 471
- engine corrosion 83, 515
- engine deposits 25, 26, 203, 331, 344–345, 347, 403
- engine development 1, 297, 377, 468
- engine efficiency 1, 12–14, 33, 60, 72, 75–86, 113, 156, 176, 179, 356, 403, 405, 438
- engine emissions 12, 41, 48, 345
- engine fuels 2, 180
- engine knock 1, 8, 23, 70, 75, 263
- engine performance 3, 11, 17, 77, 83, 84, 132, 161, 170, 178, 224, 248, 381, 382, 405
- Erren, Rudolf 376
- Ethanol 425
 Brazil 22–23
 in Europe 20–22
 United States 23–24
- ethyl tert-butyl ether (ETBE) 11, 28, 59, 81, 93, 207, 209, 248, 276–278, 416, 418, 421, 422, 426, 427
- European Automobile Manufacturers' Association (ACEA) 40, 415
- European draft standards 129
- European Emission test cycle 176
- exhaust catalysts 136, 501
- exhaust emissions 49, 73, 78–81, 83–86, 129, 135, 151, 386–387, 523
- exhaust gas catalysis 475, 479, 487
- exhaust gas control technology 484
- Exhaust Gas Recirculation (EGR) 11, 40, 139, 176, 178, 188, 266, 281, 382, 387, 396, 483
- exhaust-gas converter system 486
- expander plants 106, 107
- extruded catalysts 478

f

Fast-Fill Refueling 134
 fatty acid alkyl ester fuels 27
 fatty acid methyl ester (FAME) 28,
 114, 171, 248, 315
 Federal Test Procedure (FTP) 40–47
 feedstock 143–144, 214–215,
 322–324, 352, 354
 FFKM 186
 first fuel cell electric vehicles (FCEVs)
 448, 454, 459
 Fischer–Tropsch (FT) process 16, 161,
 162, 524
 hydrocarbon synthesis 10
 synthesis 142, 164–165, 168
 flame propagation 14, 388, 406
 Flash point analysis 330
 flashpoint 330–331
 floating production, storage, and
 offloading (FPSO) 168, 179
 fluoroelastomers 186
 four-cylinder in-line engines 4
 four-stroke test engines 76
 free glycerol 322, 328, 329, 333
 freezing point 505, 506, 513, 522
 front octane number (FON) 76, 412,
 413
 fuel cell electric vehicles (FCEV)
 59–61, 447–449, 459
 fuel consumption 2, 13, 19, 22, 36, 53,
 54, 57, 69, 70, 72, 81, 95, 113, 171,
 178, 184, 201, 208, 228, 266, 288,
 309, 385, 386, 432, 437, 438, 501,
 507, 523, 529
 fuel efficiency 2, 49, 51, 70, 156, 176,
 179, 204, 297, 433, 436, 475, 499
 fuel induction techniques 383, 384,
 389
 fuel injection systems 1, 15, 16, 70, 72,
 188, 225, 383, 386
 fuel inspection tests 513
 fuel lubricity 82, 343, 517
 fuel oxygenates 403, 405, 415, 417–420
 fuel stability 84, 221, 315, 323,
 341–342, 349–350, 356, 540
 fuel system icing inhibitor (FSII) 521
 fuel volatility 77, 82, 84

fuel-efficient engines 178–179, 469,
 501
 fuel-efficient lean engines 475
 fuel-injection systems 1
 fuels cells
 air supply system 452–453
 auxiliary components 452
 cold-start and freeze-start 459
 cooling circuit 454
 costs, durability and reliability
 457–459
 efficiency of 459–460
 fuel cell control unit (FCCU) 455
 HV battery 455
 hydrogen supply system 454
 integrated system design 455–456
 onboard-hydrogen storage 456–457
 vehicle control unit (VCU) 455
 Fuels Quality Directive 195

g

gas consumption 121
 gas engines 3–4, 136
 gas streams 101, 104–107, 124–126,
 261
 gas-based methanol 270, 289
 gas-cooled reactors 257–258
 gas-to-liquids 59, 120, 161, 201, 315
 gas-bag car 31
 gaseous hydrogen 394–395, 456
 gasoline 78, 403
 additive 1
 blending component 203
 cold flow properties 83
 density of diesel fuel 82
 diesel combustion process 82
 engines 500
 exhaust emissions 84–86
 formulation 78
 fuel composition 78–81
 fuel volatility 77, 82
 ignition quality 82
 injection technology 12
 knock resistance 405
 lean-burn exhaust gas treatment
 500
 lubricity 83

- gasoline (*contd.*)
 - octane quality 75–77
 - performance additives 82, 86
 - pump 9
 - stability, cleanliness 81–82
 - sulfur content 83
 - viscosity 84
 - volatility 77, 84, 405
 - Geely Auto Group 266
 - German oil companies 78
 - global warming 2, 12, 36, 285, 286, 468, 523
 - global warming potential (GWP) 374, 473
 - glycerol 143, 261, 318–322, 328–329, 333, 342, 360–362, 364
 - glycol dehydration 124, 126
 - granting type-approval authority (GTAA) 39
 - greenhouse gas 468
 - emissions 63
 - reduction 63
 - GTL naphtha
 - C₄ to C₁₁ hydrocarbons 201
 - gasoline direct injection (GDI) research engine 202
 - high temperature Fischer–Tropsch (HTFT) coal 202
 - low octane gasoline blending components 201
 - low temperature Fischer–Tropsch (LTFT) 202
 - modern spark ignition engine 201
 - volumetric fuel consumption 201
 - GTL technology 162, 170, 179
- h**
- Hart, William 30
 - heat of vaporization 226, 228, 263, 289, 309
 - heavy duty diesel engines 29, 135, 178, 265
 - heavy heavy-duty diesel truck (HHDDT) driving cycle 189
 - high frequency reciprocating rig (HFFR) 185, 343
 - high stoichiometric ratio 381
 - high-temperature oxidation 514
 - homogeneous-charge spark-ignition gasoline engines 11
 - Honda 266, 448, 453, 454, 456
 - honeycomb converters 476
 - household appliances 20
 - hybrid electric powertrain
 - batteries 440–443
 - degree of hybridization 436–437
 - E-drive and sailing 439–440
 - energy management 443–444
 - fuel consumption 432
 - load point shift/boosting 438–439
 - market situation 444
 - parallel hybrids 434–435
 - power-split hybrid 435–436
 - regenerative braking 437–438
 - serial configuration 433–434
 - topologies 432
 - worldwide regulation of CO₂ emissions 432
 - hydrocarbon composition 407, 536
 - hydrocarbon emissions 90, 97, 136, 265, 311, 467, 472, 484
 - hydrocarbon fuel 141–142, 417, 471, 525
 - hydrocarbon oil 107
 - hydrocarbon streams 17, 404
 - hydrocracked gas oil 95
 - hydrocracking 91, 102, 104, 165–166, 354
 - hydrodeoxygenation 353, 525
 - hydrogen 397
 - in CI engines 389–391
 - combustion characteristics 387–389
 - design criteria for, hydrogen engine 382–384
 - detection 393
 - exhaust emissions 386–387
 - hydrogen-compressed natural gas (CNG) blend 391
 - hydrogen-fueled Wankel engine 384–385
 - hydrogen-fuelled SI engine 385–386
 - integrated hydrogen energy system 374

- internal combustion engine
 395–397
 life-cycle analysis 373–374
 properties 377–381
 research and development 375–377
 safety criteria 392–393
 storage 393–394
 transportation and distribution
 systems 394–395
 undesirable combustion phenomena
 381–382
 hydrogen and CNG (HCNG) 376, 391
 hydrogen engine 385
 research 375–377, 388
 technology 376, 381
 hydrogen production 60, 62–63, 167,
 373–375
 hydrogen sulfide 108–109, 122,
 126, 145, 147–150, 167, 515, 521
 hydrogen supplemented SI engines
 375
 hydrogen supply system 452, 454
 hydrogenated nitrile rubber (HNBR)
 186
 hydrogen-diesel dual fuelled engines
 375, 391
 hydrogen-fuelled diesel engine 381
 hydrogenated vegetable oils
 EN 15940 standard 351
 hydroprocessing 165–166, 517
 hydrotreated vegetable oils (HVOs)
 24–25, 59, 315, 317, 346,
 351–366
 hydrotreatment process 25
 Hyundai 266, 448, 453, 454,
 456
- i**
- ignition energy 378–379, 381–383,
 406
 IH² technology
 catalytic hydropyrolysis process 167
 history 166–167
 hydropyrolysis reactor 167
 on-site hydrogen production 167
 In-Service Conformity (ISC) 39
 in-situ transesterification 320
- Indian National Renewable Energy
 laboratory (NREL) 374
 Indirect Land Use Change (ILUC) 57,
 215, 217, 361
 industrial oil mills 346
 industrial production 319–321
 intake valve closure (IVC) 383, 389
 integrated development process 501
 Integrated Gasification Combined Cycle
 (IGCC) technologies 258
 Integrated Storage Systems (ISSs) 138
 integrated system design 455
 internal combustion engines 4, 61,
 135, 178, 207, 261, 375, 395–397,
 416, 431, 433, 434, 437–439, 443,
 454, 456–458, 468, 472
 International Maritime Organization
 (IMO) 269, 537
 International Methanol Producers and
 Consumers Association
 (IMPCA) 258
 iodine value 329, 333, 349–350
 isentropic compressibilities 309
 Iso-OctAne 427–428
 Iso-OctEne 427
 isomerate 78, 92, 403, 413
 isomerization 9, 92, 96, 171, 204, 279,
 353, 354, 404
 isomerization reactor 354
 isomerized product 353
 isothermal compressibilities 309
- j**
- Jatropha 324, 350, 352, 358–359
 Jatropha/algae fuel options 195
 Jet Fuel Thermal Oxidation Tester
 (JFTOT) 515
 JP-1 505
 JRC study 56–63, 154–156, 192, 195,
 231, 239, 357–359, 363, 364
- k**
- kerosene 1, 23, 83, 95, 104, 505–506,
 512, 519, 524–525
 kinematic viscosity 25, 185, 333, 339,
 347–348
 knock phenomena 406

knock resistance 135–136, 228, 287,
403, 405–407

I

lambda sensor 132, 139–140

land use change (LUC) 56, 57,
215–217, 357

large-scale storage 271

lead susceptibility 413

lean misfire limit (LML) 389

Lenoir engine 18

Lenoir, Etienne 29

Li-ion technology 441, 442

life cycle impact assessment (LCIA)
374

life cycle inventory (LCI) analysis 374

light-duty vehicles 34, 45, 177, 419,
483

linolenic acid methyl ester 328

liquefaction 10, 31, 106, 127, 142, 154,
212, 524

liquefied natural gas (LNG) 32, 106,
119–120, 127, 135, 138, 150, 154,
184, 270

liquefied petroleum gas (LPG) 28–30
aboveground storage 110

absorptive purification 109–110

adsorption 107

adsorptive purification 109

environmental benefits 113–115

extraction 101

lean oil absorption 107

physical properties 102

processing of crude oil 101

recovery from natural gas 103–107

refinery conversion processes 101

refinery production 101

refrigeration

combined processes 107

expander plants 106

low-temperature separation (LTS)
105–106

refueling infrastructure 112

safety aspects 115–116

standards and regulations 112–113

thermal and catalytic cracking 104

transportation 111

underground storage 110

uses 111–112

vehicle conversions 113

liquid hydrogen 63, 393–395, 447, 456,
525

liquid organic hydrogen carriers
(LOHC) 456

long-chain alkanes 536

long-distance transport 126–127, 154

low emission vehicle (LEV) 43, 45, 46

low fuel temperature 513

low-temperature FT synthesis 163,
165

low-temperature separation (LTS) 105,
106

lower heating value (LHV) 57, 132,
288–289, 309, 339

lower octane fuels 204

lubricity 82, 83, 86, 95, 174, 180, 181,
183, 185, 187–188, 229, 281, 309,
343, 357, 517–518, 520–521, 524

luminometer 512

Lurgi combined reactor system 258

Lurgi process 260

Lynch, Frank 391

m

marine fuel 269–270

distillate fuel 537

history 535

hydrocarbon composition 536–537

residual fuels 537–540

specification 536

Markus, Siegfried 29

MARPOL 269, 537

Maschinenfabrik Augsburg Nürnberg
(MAN) factory 14, 270

material compatibility 221, 229,
343–344, 357, 416, 524

membrane-electrode-assembly (MEA)
449, 459

mercaptans 108–109, 122, 126, 127

Mercedes Benz 1, 17, 447–448, 453,
456–457

mercury 151

metals 344

deactivators 515, 520, 522

- hydride storage 394
- metal-containing additives
 - alkyl lead compounds 412–414
 - methylcyclopentadienyl manganese tricarbonyl 414–415
- metallic monoliths 477–478
- methane number (MN) 129
- methanol 424
 - anti-knock agents 248
 - biomass-based methanol 291–292
 - cetane number 249
 - CO₂-hydrogenation 260–261
 - coal-based methanol 289–291
 - consumption 249
 - conventional gasoline 249
 - demand in 250
 - distillation 258–259
 - engine performance 248
 - explosion and fire control 270–281
 - fire fighting 271
 - fire prevention 271
 - fossil sources 249
 - fuel, role of
 - global methanol market 261
 - history of 263–264
 - vehicle developments 265–268
 - worldwide methanol consumption 261
- fuel/fuel additives
 - dimethylcarbonate and methyl formate 285–289
 - DME 279–281
 - methanol-to-gasoline (MTG) 274–276
 - methyl *tert*-butyl ether (MTBE) 276–278
 - oxymethylene dimethyl ether (OME) 281–285
 - tert* amyl methyl ether (TAME) 278–279
- fuels or fuel derivatives 250
- gas-based methanol 289
- hazards 272–273
- large-scale transportation 272
- Liquid Phase Methanol Synthesis 258
- marine fuel 269–270
- methanol synthesis 255
- physical and chemical properties 249
- recycle of carbon dioxide 292–297
- renewable methanol capacity 251
- renewable methanol production
 - processes 259–261
- safety regulations, transportation 272
- small-scale storage 271
- sustainable production methods 249
- synthesis gas generation 252–255
- world-wide consumption of 250
- worldwide methanol demand 250, 252
- methanol to gasoline (MTG) process
 - 142, 274–276
 - fuel properties 203–204
 - production process 202
- methyl *tert*-butyl ether (MTBE) 11, 23, 81, 93, 248, 261, 264, 273, 276–278, 292, 416–428
- methylcyclopentadienyl manganese tricarbonyl 411, 414–415
- methyl formate 183, 285–289
- 2-methylfuran(MF)
 - combustion and emissions 311–312
 - properties of 309–310
 - synthesis of 307–308
- α -methylnaphthalene 82
- microalgae 324–325, 327
- Mitsubishi 266, 280, 288
- Modern engine knock sensors 70
- modified coating techniques 478
- molecular sieve units 109
- monoethanolamine (MEA) 126, 449, 459
- monoglycerides (MG) 310, 328, 332, 333, 340–341
- monolithic converters 476
- motor fuel, role of
 - methanol for Otto engines 264–265
- motor octane number (MON) 76, 89–90, 129, 202, 224–225, 266, 309, 407, 427

- multi-point injection (MPI) 12, 139
 - multi-pressure/temperature
 - high-frequency reciprocating rig (MPT-HFFR) 185
 - multicylinder engine 382
 - MY2015 gasoline turbochargers 13
- n**
- naphthalenes content 513
 - Napier Deltic engine 15
 - National Standard Aviation Fuel Test Methods 511–512
 - natural gas
 - automotive fuel 129–134
 - combustion and emissions 139–141
 - compositions
 - component 121
 - compressed natural gas (CNG) tank filling 122
 - domestic and industrial burners 122
 - issue of transportation 31
 - occurrence
 - gas-producing countries 120
 - global gas demand 121
 - industrial purposes 119
 - liquefied natural gas 119
 - processing
 - absorption method 125
 - cryogenic expansion process 126
 - oil and condensate removal 124
 - sulfur and carbon dioxide removal 126
 - water removal 124–125
 - safety aspects 141
 - transport/distribution/local blending 126–127
 - vehicle and engine concepts 134–137
 - vehicle fuel supply system 138–139
 - vehicle refueling systems 133
 - natural gas distributor (NGD) 139
 - natural gas vehicles (NGVs) 31–32, 135, 137–138
 - New European Driving Cycle (NEDC)
 - 38, 57, 61, 176, 283, 437, 468
 - test cycle 176
 - n*-hydrocarbons 513, 518
 - NiMH-batteries 441–442
 - nitrogen oxides 34–35, 48, 51, 73, 78, 175, 188, 217–218, 263, 345, 387, 415, 451, 483, 523
 - nitrogen oxide emissions (NO_x) 177, 178, 188, 217–218, 387, 397, 467
 - adsorber catalyst 500
 - reduction 499
 - treatment
 - adsorber catalyst 495–496
 - SCR with ammonia 496
 - noncatalyst cars 79
- o**
- octane enhancers
 - ashless octane enhancers 415
 - combustion in 405–406
 - knock phenomena 406
 - pure hydrocarbon components 427–428
 - types of 409–427
 - octane number (ON) 75, 406–409
 - determination 76
 - octane rating 201–202, 204, 225, 228, 230, 309, 311, 422, 529–531
 - odorant 127, 132, 151, 181, 186
 - odorization 127
 - olefin-rich fuel 414
 - onboard-hydrogen storage 456–457
 - optimum engine operation 2, 73
 - Otto engines
 - gas exchange processes 69
 - modern electronic fuel injection systems 70
 - octane number requirement 70
 - principle of 69
 - rotary engine 69
 - sequence of strokes 69
 - throttled intake air 70
 - two-stroke 69
 - Otto four-stroke engine 3
 - Otto-cycle engine 13
 - oxidation inhibitors 8, 514, 520
 - oxide ash 330
 - oxygen sensors 12
 - oxygen-storage components 479, 486

- oxygenated liquids 524
 - oxygenates 8, 23, 93, 129, 165, 202, 226–227, 264, 281, 297, 403, 405, 408, 415–417, 420–421, 423–424, 426, 427, 531
 - oxymethylene dimethyl ether (OME) 180–189, 281–285, 316
- p**
- palm oil 26, 320, 322, 352, 358–359, 361–363
 - n*-paraffins 8, 83, 93, 334, 353
 - paraffin-rich fuel 414
 - paraffinic crude oil 536
 - paraffinic wax formation 538
 - parallel hybrids 434–435, 438
 - particulate emissions 34, 45, 83, 93, 115, 135, 180, 201, 230, 268, 472–473, 490
 - particulate filter 478
 - ash load 493
 - cordierite filters 492
 - filter material 492
 - filtration efficiency 492
 - open filter system 493–494
 - soot oxidation 492–493
 - working principle 491–492
 - particulate filter regeneration 490
 - passive recirculation 454
 - Patrick, J. 26
 - penicillin 213
 - petrodiesel fuel 25
 - petroleum-derived fuels
 - alkylate 92
 - catalytic reformat (platformate) 92
 - catalytically cracked gas oil 94–95
 - catalytically cracked gasoline 91–92
 - diesel fuel components 93–96
 - gasoline components 89, 90, 92, 93
 - hydrocracked gas oil 95
 - isomerate 92
 - kerosene 95
 - oxygenates 93
 - polymer gasoline 92
 - storage and transportation 96–98
 - straight-run gasoline 89–90
 - straight-run middle distillate 93–94
 - synthetic diesel fuel 96
 - thermally cracked gas oil 94
 - thermally cracked gasoline 91
 - pHe value 222
 - Philips, Frank 29
 - photobioreactor 324–326
 - piston engines 3, 69, 529–530
 - platinum group metals (PGMs) 479
 - catalysts 450
 - Plug-in hybrid electric vehicles (PHEV) 39, 60, 432, 437
 - polymer gasoline 92, 403
 - polyunsaturated fatty acids (PUFA) 322, 327–328, 349–350
 - polyunsaturated methyl esters content 327
 - polyurethane 186, 229, 288
 - positive crankcase ventilation (PCV) 383
 - power-split hybrid 435–436, 438
 - preignition 378, 381–384, 388
 - pressure swing adsorption 147, 149, 167, 213
 - problem-free gasoline storage 81
 - proton exchange membrane fuel cells (PEMFC) 447
 - pyrolysis 24, 26, 166–167, 348, 375
 - pyrolysis gasoline 91
- q**
- Qualified Products Lists (QPLs) 520
 - Quench reactors 256
- r**
- Real Driving Emissions (RDE) 38
 - test 39
 - legislation 38
 - recontacting 104
 - refinery conversion processes 101, 104
 - reformulated gasolines 78, 417
 - regenerative braking 434, 437–438
 - Reid vapor pressure (RVP) 226–227, 265, 422–424, 516
 - renewable fuel standard (RFS) 24, 182

- research octane number (RON) 10,
75–76, 89–90, 129, 202, 224–226,
266–269, 281, 287, 289, 309, 404,
407–408, 415, 421–423, 427
- residual fuel oils 535–538
- residual methanol content 330
- reverse transesterification 341–342
- Ricardo, Harry 8, 21
- road octane number 76
- 95 RON Fiat/Chrysler gasoline engine
268
- S**
- sailing mode 440
- SAPOs 353
- SASOL 162
- Saturated monoglycerides 340
- SCR catalysts 475, 479, 490, 496–498,
500
- Selden, George B. 29
- self-combustion 1
- sensitivity 76, 224, 228, 309, 319, 327,
344, 407, 409, 421, 486, 517
- Separometer 516
- serial hybrids 433–435
- Shell Middle Distillate Synthesis
(SMDS) process 524
- Shell Sulfinol process 126
- siloxanes 132
- single-bed oxidation catalyst 484
- slow-fill refueling 133
- smoke point 512, 519
- Snelling, Walter 28
- solid-desiccant dehydration 125
- solid electrolyte interface (SEI) 442
- solid oxide electrolysis cell (SOEC) 170
- solid oxide fuel cells (SOFC) 456
- solid particle number (SPN) 45
- soybeans 168, 321, 324, 334, 350, 352,
358
- spark ignition engines 5, 29, 129, 135,
201–202, 281, 381, 387, 471,
483–484, 529
- spark timing 5, 70, 207, 379, 396,
405
- spark-ignited engine 1, 63
- spark-ignited Otto engine 14, 15
- spark-ignition engines 5, 29, 129, 135,
201–202, 281, 381, 387, 471,
483–484, 529
- spark-ignition gasoline engines 11, 468
- state-of-the-art catalysts 480
- state-of-the-art emission control
technologies 501
- static dissipater additive (SDA) 516,
520–521
- static electricity 116, 382, 516
- sterol glucosides (SG) 340
- stoichiometric spark-ignition engines
483–484
- stop-start concepts 13
- storage 94, 110–111, 149–150, 271,
393–394, 424, 456–457,
485–487, 522–523
- storage system 138, 228, 456, 468
- sulfated ash 331, 333
- sulfates 167, 213, 221, 224, 331, 353,
473, 496, 497, 521
- sulfur 151, 515
- content 81–83, 85, 127, 129, 132,
148, 171, 203, 269, 333, 422, 473,
489, 491, 512, 537–539
- free gasolines 81
- Super Ultra Low Emission Vehicles
(SULEV) 43, 419
- synthetic gas (SNG) 60, 168, 170
- t**
- tank-to-wheel (TTW)
- CO₂ emissions 196
- emissions 33
- simulations 60
- tert*-butanol (TBA) 278, 416, 422, 425
- tetramethyllead (TML) 412–413, 423
- thermal efficiency 3, 176, 224, 311,
356, 376, 381–382, 384–386, 391
- thermal cracking 7, 9, 91, 102, 104
- thermally cracked gasoline 91
- thermodynamic equilibria 475
- thiol sulfur 519
- thiols 515, 518–519
- three-way catalysts 500
- closed-loop control 484
- conversion efficiencies 484

- oxygen storage 485
 - precious metals 487
 - range of λ ; values 485
 - tight process 480
 - timed manifold injection (TMI)
 - 384–386, 388, 396
 - total contamination 343, 350
 - total glycerol content 329
 - Toyota 266, 435, 441, 448, 453–455
 - Toyota Hybrid System 431
 - transesterification 26, 59, 318–321,
 - 329, 339, 341–342, 352, 357, 360
 - transportation 96–98, 110–111, 150,
 - 272, 394–395, 424, 447–449, 522–523
 - triglycerides (TG) 328, 525
- U**
- unburned hydrocarbons 78, 136, 140,
 - 176, 383, 523
 - underground storage 110, 418
 - unit direct injection 17
 - U.S. Environmental Protection Agency 182
 - US ethanol-blended gasolines 424
- V**
- vanadium 478, 490, 497–498,
 - 536–537, 539
 - Vanadium SCR Catalysts 497–498
 - vapor pressure 77, 89–90, 101,
 - 109–110, 185–186, 188, 203, 221, 226–227, 230, 239, 265, 270, 276, 287, 288, 309, 405, 409, 422, 424, 512, 516–517, 531
 - variable valve lift (VVL) 13
 - variable valve timing (VVT) 13
 - vegetable oils (VO) 24–26, 317
 - fuel properties
 - acid value 350
 - calcium, magnesium and phosphorus 350
 - carbon residue 348
 - cetane number 348
 - density 348–349
 - flash point 348
 - fuel stability 349–350
 - heating value 348
 - iodine value 349
 - total contamination 350
 - water content 350
 - production 346
 - vegetable oil crude 28
 - Vehicle Technology 60, 135–137
 - Virginiamycin 213
 - visbreaking 91, 94
 - viscosity 25–26, 82, 84, 95, 175, 180,
 - 185, 187–188, 212, 265, 278, 281, 284, 315, 318, 332–334, 339, 341, 347–350, 356, 512–514, 536–538, 540
 - volatile fuel viscometer (VFVM) 185
 - volatile organic compounds (VOC) 35,
 - 287, 289, 451, 467
 - volatility 1, 5, 8, 77, 81, 82, 84, 89, 92,
 - 226–227, 230, 309, 312, 336, 341, 355, 405, 414, 417, 420–421, 427, 512
 - volatility properties 423–424
 - Volkswagen swirl-chamber combustion system 266
- W**
- wall quenching 472
 - washcoated ceramic monolith 478
 - water 151
 - content 228, 343
 - solubility 309
 - water footprint (WF) 56, 219, 324, 357
 - Wobbe Index (WI) 132
 - water miscibility 517
 - Water Reaction test 516
 - well-to-tank (WTT)
 - analysis
 - bioethanol 236–237
 - biomethane 152–155
 - DME 193–195
 - emissions 33
 - well-to-wheel (WTW) 55–56
 - analysis 156–158
 - bioethanol 237–240
 - DME 195–196
 - XTL 190–193, 195–196
 - efficiencies 459–460
 - energy 60

wet gas stream 124

Worldwide Harmonized Light Vehicles
Test Procedure (WLTP) 38, 48,
448

X

XTL fuels 59, 170–171, 175
Fischer–Tropsch Synthesis 164–165
history 162

hydroprocessing 165–166
syngas manufacturing 163–164

Z

zeolites 149, 213–214, 279, 283, 353,
479, 480, 491, 494, 498
Zeolite-based SCR catalysts 498
Zero Emission Vehicles (ZEV) standards
43, 419